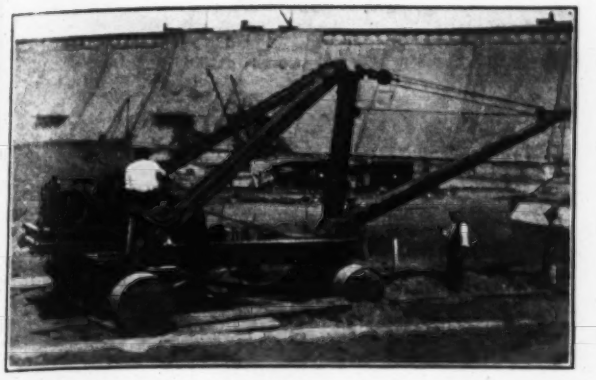


FIG. 3. A TRAVELING DERRICK BUILT FROM SCRAPS

from the scrap heap) and an idle 5-hp. motor. This arrangement (see Fig. 2) mounted on a flat car handled 5,000 cu.yd. of sand in one season.

A portable derrick for setting concrete curbs was evolved from an idle 15-hp. electric hoist, some derrick fittings and second-hand timbers. This excellent machine not only could haul itself along on plankways, but could also draw the curb from the nearest railroad track to the place of setting. In 97 days 13,000 lin.ft. of curb was set.

Table and Chart for Wind-Pressure Formulas

By Harry B. Wrigley*

The normal pressure upon an inclined surface varies with the inclination of the roof. Three formulas for this variation are in common use: Hutton's (derived in 1788),

$$P_n = P \sin A^{1.83 \cos A - 1}$$

Duchemin's (derived in 1829),

$$P_n = P \frac{2 \sin A}{1 + \sin^2 A}$$

straight line (recent),

$$P_n = P \frac{A}{45}$$

where

P = Pressure on a vertical surface;
P_n = Pressure normal to roof surface;
A = Angle which the roof surface makes with the horizontal.

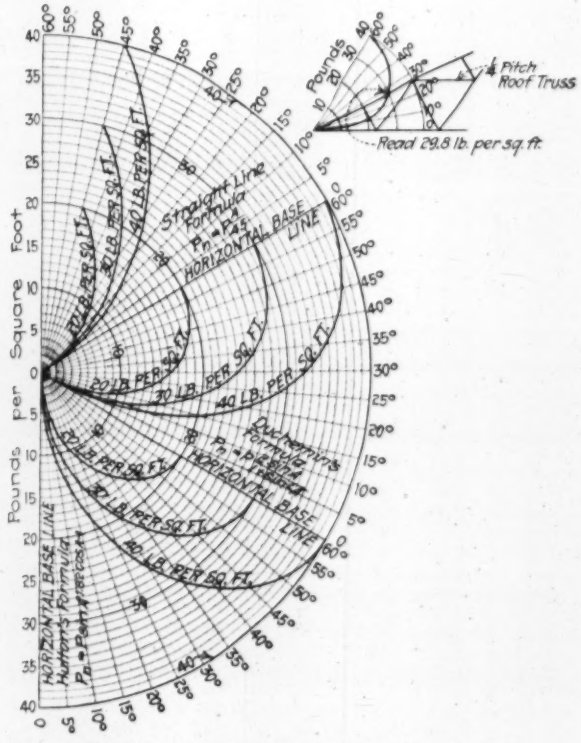
In the accompanying table the 20, 30 and 40 heading the columns represent P, and the values underneath are the corresponding P_n values for the angle A.

TABLE OF NORMAL PRESSURES OF WIND

A	Hutton			Duchemin			Straight Line		
	20	30	40	20	30	40	20	30	40
5°	2 6	3 9	5 2	3 5	5 2	6 9	2 2	3 3	4 4
10°	4 8	7 2	9 6	6 7	10 1	13 5	4 4	6 7	8 9
15°	7 0	10 5	14 0	9 7	14 6	19 4	6 7	10 0	13 3
18° 26′	8 7	13 0	17 3	11 5	17 2	23 0	8 2	12 3	16 4
20°	9 2	13 7	18 3	12 2	18 4	24 5	8 9	13 3	17 8
21° 48′	10 0	15 0	20 0	13 0	19 6	26 1	9 7	14 5	19 4
25°	11 3	16 9	22 5	14 3	21 5	28 7	11 1	16 7	22 2
26° 34′	12 0	18 0	24 0	14 9	22 4	29 8	11 8	17 7	23 6
30°	13 3	19 9	26 5	16 0	24 0	32 0	13 3	20 0	26 7
33° 41′	14 7	22 0	29 3	17 0	25 4	34 0	15 0	22 5	30 0
35°	15 0	22 6	30 1	17 3	25 9	34 5	15 6	23 3	31 1
40°	16 7	25 1	33 4	18 2	27 3	36 4	17 8	26 7	35 6
45°	18 0	27 1	36 1	18 9	28 3	37 7	20 0	30 0	40 0
50°	19 0	28 6	38 1	19 3	29 0	38 6			
55°	19 8	29 7	39 6	19 6	29 4	39 2			
60°	20 0	30 0	40 0	19 8	29 7	39 6			
60° to 90°	20 0	30 0	40 0	20 0	30 0	40 0			

Some may find the chart form more convenient than the table form. The polar-coördinate chart herewith can be applied directly to the drawing of a roof and the value of normal pressure read off at the intersection of the roof plane with the proper curve. Radial distances are the values of normal pressure. In using the chart care must be taken to place the proper line horizontal.

*19th and B St., N. W., Washington, D. C.


Pounds per Square Foot
Pounds
Pitch
Roof Truss
Read 29.8 lb. per sq. ft.
HORIZONTAL BASE LINE
Straight Line Formula
Pn = P/45
Duchemin's Formula
Pn = P 2 sin A / 1 + sin² A
Hutton's Formula
Pn = P sin^(1.83 cos A - 1)
20 LB. PER SQ. FT.
30 LB. PER SQ. FT.
40 LB. PER SQ. FT.

NORMAL WIND PRESSURE ON ROOFS

Some may find the chart form more convenient than the table form. The polar-coördinate chart herewith can be applied directly to the drawing of a roof and the value of normal pressure read off at the intersection of the roof plane with the proper curve. Radial distances are the values of normal pressure. In using the chart care must be taken to place the proper line horizontal.

Triangulation Details for Bridge Survey

In the triangulation for a recently built bridge of long span two details of special design were used—an observing shelter and a tripod target. They are illustrated by sketches herewith.

The triangulation house for sheltering the instrument was a square box 5x5 ft., 6 ft. high to roof, with windows in two adjoining sides and equipped with a target fixed to the peak of the roof. It was built of 3x3-in. posts and joists and vertical 1-in. sheathing, the roof being shingled. Besides the two observation windows there was a door with lock. It was built on four posts, or hubs, set solidly at the four corners. The target, 7½x1 in., 30 in. high, was painted red and white, with a central vertical white line. It sat on a 1½-in. base 16 in. in diameter, held down by four hook-bolts. A hole in the front of the house provided for tape measurement.

The cost of two houses was about $22 for material and $30 for labor, a total of about $26 per house.

The tripod target, fully shown, was made of the following material: 3-in. top, 3 in. and 12 in. on a side, fitted with a level; 3x3-in. tapered legs, attached by 6-in.

T-hinges; leg tips formed by round-headed screws, seating in countersunk holes in old hinges nailed to the tops of three base hubs; stovepipe for windshield for the plumb-bob string; and a 6x¾-in. target 30 in high,

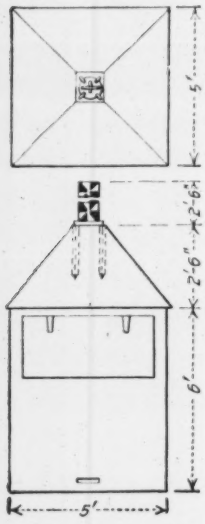


FIG. 1. OBSERVING HOUSE FOR TRIANGULATION

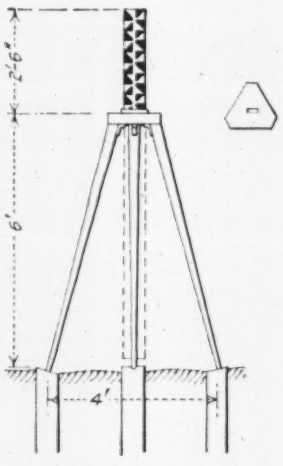


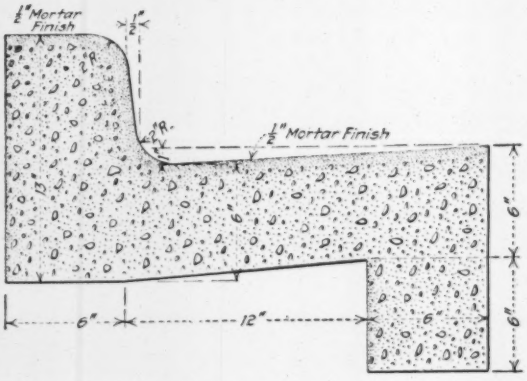
FIG. 2. TRIPOD TARGET FOR TRIANGULATION

seated on a base plate 8x8x1½ in. fastened by clamps to the tripod top.

Two tripod targets cost $5 for material and $8 for labor, or a total of $6.50 each. The type of target proved very good on long sights.

NOTES

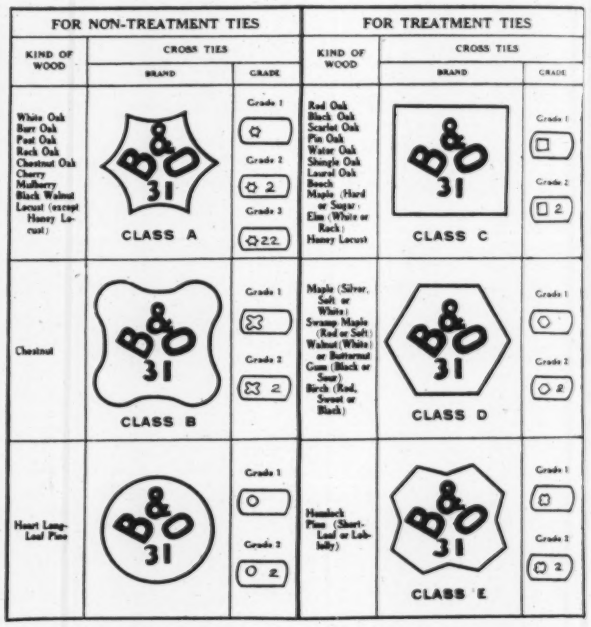
Combined Concrete Curb and Gutter—The accompanying sketch shows the form and dimensions of the concrete curb and gutter used by A. R. Young, City Engineer of Topeka, Kan. There are many miles of this construction in the city, and it is all in excellent condition. The concrete wall, or edging, next the pavement has been found to prevent many previous troubles. This edging extends from 4 to 6 in. below the base of the pavement and permits a thorough rolling of the subgrade and of the pavement without crowding the material under the edge of the apron and cracking or displacing the curbing. The ½-in. mortar facing is placed while the concrete is green, by pushing over it a traveling steel templet, the mortar being properly distributed ahead of this machine.



COMBINED CONCRETE CURB AND GUTTER, TOPEKA, KAN.

Light-Reflecting Value of Paint—New tests of the light-reflecting value of white and colored paints are reported by Henry A. Gardner, of the Institute of Industrial Research, Washington, D. C., in a recent paper. Prior figures on this subject are in general confirmed, but somewhat higher percentages of light reflection are shown. An interesting [illegible] spherical integrating photometer chamber was used. The final values were based on a comparison with a block of white magnesium carbonate, the reflecting value of this being assumed at 88% from the figure found by earlier experimenters. A dark-colored linseed oil gave a coefficient only 6% less in reflecting value than a very light-colored flat varnish (61% against 67%). Gloss and flat varnishes gave the same coefficient, in contradiction of ordinary impressions. The effect of lampblack admixture was found to be very powerful in suppressing light reflection; a white pigment, which by itself (in flat varnish) gave 66% reflection, dropped to 44 when its color was changed to a light gray by lampblack, and to 27% when the color was made gray. Among colored paints the light cream, light pink, light yellow, light blue and light buff gave reflections over 50%, ranging from 66 down to 52 in the order named. Light green and light terra cotta showed percentages between 40 and 50, light and medium terra cotta being close to 40%; then downward the blues, greens and reds caused very rapid drop in the reflecting power, bright blue, green or red giving coefficients between 11 and 14%. The importance of these figures with relation to interior finish is obvious. Track experiments made by measuring the heat absorption of various pigments and paints were in general agreement with the photometer tests.

Crossties Are Branded after inspection by Baltimore & Ohio R.R. inspectors with a hammer having changeable heads, so that the brand will indicate the class and grade of the tie. This precaution is to prevent the ties purchased for treatment from being confused with white-oak or other nontreatment



BRANDS FOR CROSSTIES OF BALTIMORE & OHIO R.R.

ties and put into tracks before being treated, and to prevent the nontreatment ties from being shipped to treating plants. As the sketch shows, the brands for treatment ties are made of straight lines, and for nontreatment ties of curved lines. A tie bearing only the brand is a Grade 1 tie; accompanied by the figure 2, it indicates a grade 2 tie. Switch ties, bridge ties and piling are branded the same as grade 1 crossties—"Wood-Preserving."

The Wire Drag has revolutionized hydrographic surveying, says the annual report of the Coast and Geodetic Survey. It has long been realized that soundings with the leadline, no matter how carefully and closely spaced, were not infallible, and that submerged rocks and ledges were often missed, as has been demonstrated by numerous wrecks and frequent damage due to striking unknown rocks in surveyed waters; but with the development of wire-drag hydrography, these submerged dangers have been discovered and charted.

Editorials

Canadian Court Upholds Rights of Contractor

A notable suit was decided by the Superior Court of Montreal, Canada, on Jan. 17, in which was involved the right of a contractor to square dealing and prompt payment of monthly estimates. According to the evidence in the suit, Geo. W. T. Nicholson, a Montreal contractor, at the end of 1909 took a contract to build a power plant for the Canadian Light and Power Co. Under the agreement the contractor was to receive monthly payments on certificate by the company's engineer and final payment within 30 days after completion and acceptance of the work.

When the work was partly completed, one of the officers of the company conceived the idea of saving some money by inducing the contractor to consent to a change in the terms of the contract regarding the measurement of the material. This official knew that the contractor was hard up for money and that the payday for his men was four days overdue. The company itself was behind in the payment of its monthly estimate, then due. Taking advantage of this knowledge, the official induced the contractor to sign a letter agreeing to a change in the method of measurement, threatening that otherwise the company would further withhold payment of the monthly estimate. The engineers of the company, when the letter was shown them, protested that such a change in the terms of payment was unfair to the contractor.

It was further established to the satisfaction of the court that by the terms of an agreement made between the company and its engineers at a later date, the engineers became mere servants of the company and not independent certifying engineers. Under instructions from the company the engineers refused to sign a final certificate on the completion of the work, and the contractor was thrown into bankruptcy.

The judge said in his decision, "The engineer was unable to preserve an attitude of judicial independence between the parties, and this released the contractor from all conditions in his contract with the company by which he had submitted to have his rights determined by the engineer." The facts in the case were established not only by the evidence of the plaintiff, but by the engineers themselves. Under these circumstances the court gave a sweeping decision in favor of the contractor, pointing out particularly that the agreement extorted from the contractor to consent to a change of measurement was an agreement obtained by "coercion, violence and fear and was therefore null and void."

It is by no means an unprecedented procedure, unfortunately, for those who consider themselves shrewd business men to attempt to take one advantage or another of a contractor by withholding payments at the time they are due. It is of interest to have established by the courts, therefore, the fact that concessions obtained in such a manner will not be sustained by the law.

Should the Civil Engineers' Headquarters Be Moved?

The members of the American Society of Civil Engineers have received from the society's Board of Direction a statement of the proposal to remove the society's headquarters in New York City from the building now owned by the society on West 57th St. to the Engineering Societies' Building on 39th St. near 5th Ave. The general terms of the proposition on which the members are to vote by letter ballot were explained in our issue of Feb. 3. There are a number of matters in connection with the proposal which should be further explained in order that the members may be able to vote intelligently.

There are several aspects from which this proposed change in the society's headquarters may be viewed. The first of these is the business aspect. Admittedly, this is not the most important consideration in connection with the proposition, yet it deserves attention. The funds that the society has accumulated have been contributed from the earnings of thousands of hard-working engineers and should be carefully safeguarded. The first question to determine, therefore, is the comparative safety of these funds invested in the society's present house on West 57th St. and invested in the Engineering Societies' Building.

The present house of the society was built 20 years ago. At that time the part of West 57th St. where the society's house is located was a high-class residence district, and properties were increasing in value. The society has invested $185,000 of its funds in the land on which the building stands and $175,000 in the building itself. According to the recent appraisal made by real-estate experts employed by the Board of Direction the land has increased in value by about $100,000, but the building is appraised at only $35,000.

This loss of value is due, not to physical deterioration of the structure, but to a radical change in the character of the neighborhood since the building was erected. The house stands only a few doors from that part of upper Broadway which has now been entirely given over to the automobile trade. West 57th St. has become a favorite thoroughfare for motor cars. On one side of the society's house stands a high building devoted entirely to the motor-car business, with a garage close to the house. On the other side stands a church which has been abandoned by its congregation and sold, probably to make way for some business structure.

Twenty years ago, or even eight years ago, when the society built an addition to its present house, it seemed likely that the building, at any time when the society should deem best to make a change, could be sold at a fair figure for use as a club house. There is no such market for it now. If the society abandoned it, it would have to be sold for what it would bring for use as a restaurant or dance hall for those who frequent the automobile district.

The society is fortunate in that the increased value of the land for building purposes at present would partly offset the depreciation on the value of its building, in case the society should sell the property. It is apparent that it would be an unwise investment for the society to spend more money on its present house in the way of additions or alterations to meet the need for increased space. Structural values in this section, from all present indications, are much more likely to decrease—as has happened in so many other once fashionable sections of New York City—than to increase.

Turning now to the alternative—the purchase of an interest by the society in the Engineering Societies' Building on 39th St.—the situation here may be very briefly summed up as follows: The building, with the land on which it stands and the accumulated investment in the reserve fund of the societies owning it, represents an outlay of nearly $2,000,000. It is centrally located in the heart of the uptown hotel, club and theater district, where land has been steadily rising in value in the dozen years since the building was erected and is likely to have a further increase. The three other national societies that own the building, free and clear of all incumbrance, offer to admit the American Society of Civil Engineers to joint ownership in the building for the sum of $225,000 to $250,000, or for about the same outlay that the society would have made had it joined in the enterprise with the three other societies 12 years ago.

At that time the plan for a building for the joint use and occupancy of the national engineering societies was admittedly an experiment. Many were honestly doubtful whether it could be made permanently successful. The national societies of mechanical, mining and electrical engineers agreed to undertake the experiment at the same time that the Society of Civil Engineers voted against it. The experience of 12 years has proved the experiment to be a success from the financial as well as from every other point of view. These three societies now offer to admit the American Society of Civil Engineers to an equal ownership in this building—or in business terms, they offer to sell a quarter interest in a property worth in the neighborhood of $2,000,000 for a sum varying from $225,000 to $250,000, according to the plans which the civil engineers may decide to adopt.

It will be evident from the foregoing review of the financial status of the proposition that, if the American Society of Civil Engineers can sell its present house at the appraised valuation, it can pay the cost of its quarter interest in the Engineering Societies' Building and have a balance of $115,000 to $140,000 left in its treasury either for investment as a reserve fund or for any other use which the society chooses.

It should be mentioned, from the business side also, that the society will effect a considerable saving in the annual outlay for maintaining its New York headquarters—probably some $2,000 to $5,000—by removing to the Engineering Societies' Building. But as was previously remarked, the financial aspect is not by any means the most important for the society to consider. More important, without doubt, is the question as to the relative advantages of the new location for the society's headquarters as compared with the old. The headquarters of the society is, for one thing, a set of offices for the society's secretary and his staff of employees. So far as these offices are concerned, either location is satisfactory. So far as there is an advantage, it lies with the Engineering Societies' Building, by reason of its more convenient location to the new post-office building and the great uptown publishing center that is growing up in the post-office district. The space to be occupied by the society in the Engineering Building, furthermore, is on upper floors, while a large part of the space in the house on 57th St. now used for storage and various work in connection with publications is in the basement of the building.

It may be explained here that the space which the society can command in the Engineering Societies' Building will very much exceed in area the floor space in the society's present house, excluding that contained in the auditorium, which is of course proper, since in the occupancy of the Engineering Societies' Building the civil engineers would share the use of the auditoriums in the building in common with the other societies.

The headquarters of the American Society of Civil Engineers in New York City, however, ought to be not merely a set of general offices for employees, but a headquarters to which the members resident in New York City and vicinity and those who come to the city for business or pleasure will habitually resort. There is no reason why the society should not afford to its members at its headquarters in the Engineering Societies' Building some of the conveniences and attractions of a social club.

To effect this in the present house of the society has always been difficult. The building is not well arranged for this purpose and is further handicapped by its inconvenient location, especially for members out of the city who are living at hotels during their stay. The Engineering Societies' Building, on the other hand, can be reached in five to eight minutes from the Grand Central Station, the Pennsylvania Terminal, the subway and the Hudson tube. Convenience of access is a most important factor in encouraging and bringing about the use of the headquarters by the members, and unless a headquarters is resorted to by the members, no one will care to go there.

It is worth while to emphasize this point, because to the members located at a distance from New York it may appear as if the proposal before the membership is to move the society's headquarters from its own private club house to an office building. It should be clearly understood, therefore, that the new headquarters may be made more attractive as a place of resort than the old.

Those familiar with the clubs in any of the larger cities are aware that many of the social clubs which are most prosperous and successful and have the most attractive headquarters are located on the upper floors of high buildings. There is no reason whatever, therefore, why if the civil engineers decide to remove to the Engineering Societies' Building, the space they occupy there may not be so arranged and furnished as to provide not merely the office space required for the society's working staff, but spacious accommodations for those members who wish to use the society's headquarters as the rooms of engineers' clubs in the smaller cities are used.

There is even greater reason for this in the American Society of Civil Engineers than in the other national societies, since the members resident within 50 mi. of New York pay higher annual dues because of the privileges they are supposed to enjoy in the use of the society's headquarters. Such use, moreover, involves no disadvantage to a member residing at a distance. On the contrary, it is of advantage to him, whenever he may come to New

You [illegible] to be able to find at the society's headquarters a host of fellow members ready to give him a cordial welcome and to be able to use the society's rooms for correspondence, business appointments, etc.

Finally a word need be said concerning the other facilities that the American Society of Civil Engineers would enjoy through its occupancy of the Engineering Societies' Building. The main auditorium in this building, which has a seating capacity for an audience of over 1,000, is one of the finest auditoriums in New York City. It will be possible to accommodate therein every member of the society attending the annual meeting and to enable him to hear what is going on—something wholly impossible of accomplishment in the auditorium in the present Civil Engineers' house, because of its limited capacity and poor acoustic properties. In addition, the society would share with the other societies the use of the smaller auditoriums in the building and also the rooms arranged for large receptions, luncheons, etc., with kitchen and service accommodations, which occupy the entire fifth floor of the building.

One of the most attractive and important features of the proposition is the plan to unite the library of the American Society of Civil Engineers with the libraries of the other three great national societies, already consolidated, forming altogether a library of nearly 150,000 volumes and carried on as a free reference library for the use of any member of the engineering profession. By searches made by an expert staff, moreover, the facilities of the library are made available to engineers residing at a distance. It would of course be possible for the civil engineers in removing to the building to retain, if they chose, their own library and carry it on separately from the other. There would be every advantage to the members, however, in effecting the consolidation and taking advantage of the admirable system of cataloging and reference searches already worked out by the staff of the United Engineering Library.

Twelve years ago, when the offer was originally made to the American Society of Civil Engineers to join with the other national societies in building and occupying the Engineering Societies' Building, the offer was rejected when put to a vote. Reference to the discussion that took place on the proposition at that time will show that the defeat was due to misunderstanding. The reasons which were given then for the society's not joining in the enterprise have no force at the present day. It was, for example a generally held opinion a dozen years ago that the proposition to have the four societies join in erecting and occupying the building was merely an entering wedge for some movement to consolidate the societies. The experience of a dozen years, during which the mining, mechanical and electrical engineers have occupied the Engineering Societies' Building, has demonstrated that there is no interference whatever of one society in another society's affairs, nor has there been the slightest movement toward consolidation. There has been, however, an increasing amount of coöperation between the societies through their governing bodies in matters affecting the general welfare of the profession. In these coöperative movements the American Society of Civil Engineers has joined.

The testimony of many prominent members of the society who voted against the plan to coöperate with the other societies in building and occupying the great engineering headquarters in New York City a dozen years ago is that the refusal at that time was an unfortunate mistake. This mistake there is now an opportunity to rectify. The Engineering Societies' Building has become, as those who planned it hoped, a great headquarters for engineering-society activities in New York City. It is occupied not only by the three national societies previously referred to, but contains the offices of a number of other national and local engineering and scientific societies, which share in the use of the auditorium, library and other facilities that the building offers. This great headquarters has been made use of when international engineering congresses have visited New York, and it is the center from which have started many movements for the benefit of the engineering profession as a whole.

Members of the American Society of Civil Engineers are constantly coöperating with mining engineers, mechanical engineers and electrical engineers in their professional work. The present proposition is that the society as a whole should coöperate with the societies representing other branches of the profession in the ownership and occupancy of a great engineering headquarters whose success is established beyond a doubt. It can do this under conditions that safeguard the society's financial interests, effect a saving in its annual expenses, provide facilities greatly superior to those which it now has, and that will aid the society to render greater service to its members and to the profession.

Defense of Suits on Patents in Reinforced Concrete

To most engineers engaged in reinforced-concrete construction it seems exceedingly strange that some of the patents on reinforced-concrete construction should ever have been issued by the Patent Office and stranger still that these patents should have been upheld by the courts. The same thing is true of a number of other patents that interfere with the free work of engineers in design and construction, such as some of the patents on sewage disposal and on road construction.

The position of engineers with regard to the class of patents referred to is that the patents are not on a real invention, but on a particular way of doing something; and they believe further that the state of the art when the patent was issued was such that the patent should be declared void by the courts for lack of novelty.

So far as the Patent Office is concerned, it may be explained that the examiners generally confine themselves to the question whether anticipations of the construction described by an applicant can be found in existing patent records. The question whether the alleged improvement involves invention or merely mechanical skill, the examiners generally leave to the courts to determine.

In studying some of the recent patent decisions where patents of doubtful validity have been sustained one is forced to the conclusion that the reason why the courts have decided in favor of the patentee is the weak defense presented by the alleged infringers.

The defense of suits of this sort has in some cases been intrusted to ordinary attorneys, with no especial experience in patent litigation and ignorant of the proper methods of procedure to establish their case. These attorneys have picked up any engineer they might happen to know and attempted to qualify him as an expert in the branch to which the patent relates. It needs only a

study of the court decisions upholding some of these patents to perceive that the defense failed to present important evidence as to the state of the art at the time the patent was issued, or at least to present it in such a way as to carry conviction to the mind of the judge.

Unfortunately for those who have to defend suits for patent infringement, it is customary in the Federal courts, when a patent has been sustained in one circuit, to make the decision in this first case controlling, if suits for infringement are brought in any other circuit. The defense in an infringement suit, therefore, labors under a serious handicap where the patent in suit has been supported in previous decisions, even though the patentee may have won his case only because the opposing side was weak. The decision of Judge Anderson in the Bone case, however, reviewed in *Engineering News*, Feb. 10, 1916, shows that, where a clear and strong defense is presented to a judge, the precedent set by a previous decision may be overruled.

The engineering profession has no quarrel with patents on real inventions, especially where the patent is made use of as the foundation for a business. It is broadly recognized that the rewards offered by the patent system are not merely to the inventor who conceives a new idea. The monopoly which the patent system grants is justified in order to induce capital to embark on the manufacture and introduction of the new invention and to educate the public to the advantages of its use. Neither the engineering profession nor the general public oppose patent monopolies of this class; but engineers do most strenuously oppose claims to a monopoly because some man who sees fit to describe in the patent records a plan to build a piece of work in a certain way claims on the strength of that record the right to demand tribute from everyone who thereafter, for the space of 17 years, shall build work in the same way.

It is only too evident that in sustaining a number of patents of this class the courts are proceeding in a vicious circle in their decisions. In order to show that invention exists in some of the reinforced-concrete patents the judges are quoting previous decisions supporting some of the patents on road construction that are generally condemned by the engineering profession.

We cannot too strongly urge upon the authorities of cities, counties or corporations having patent suits of this class to defend that they spare no pains in obtaining the most eminent counsel and patent experts who thoroughly understand their business and can go to the bottom of the case. If a suit is handled in that way, there need be little fear of the result. A good illustration is the iniquitous Selden patent, which was held as a club over the entire automobile industry for a number of years until the importance of the case caused the most eminent counsel to be retained and the patent defeated.

Letters to the Editor

Relations Between Assistants and Chief Engineers

Sir—I have followed closely the discussion in your very interesting columns on the subject of the coöperative system of civil-engineering training and approve especially the paper by Professor Stringfellow, in your issue of Jan. 13, page 63. There is one phase of the question of education by experience which I desire to bring to the notice of engineers.

I recall two young fellows who at different times and places entered the field party in which I was working and who wanted to know the "why and wherefore" of all that was being done. Fortunately for them, they were informed by their chiefs exactly what the aim was. The result was that these men took up their duties with zeal and advanced the work prodigiously. They applied their own brain power and skill to their work, and at the present time both are high in the profession.

I also recall how I was once engaged on railroad location under an impatient and inconsiderate man, a most profane and irritable speaker, who seemingly had no time to explain even to me, who was one of his principal assistants, what his movements were aimed toward. One day I was wholly lost from him and his followers, with a mountain and a river between us. I had a level with me, but had no idea what I was taking levels for. The chief engineer of the road was with him when we finally ran across each other, and in the din that followed I am sure I had the sympathy of the "big chief." No wonder I sometimes envied the pigs along the roadside for their moments of peace and contentment, for night and day we had no cessation of pain in our hearts. In an exchange of confidences one of the best fellows in the party told me that all the week he waited for Sunday and was blue all day Sunday thinking of Monday. P. G. MELBOURNE.

Hyattsville, Md., Jan. 26, 1916.

Designers Must Provide for Telephone Conduits

Sir—In the issue of *Engineering News* for Dec. 23, 1915, p. 1236, an article entitled "Outlet Boxes for Electrical Conduits in Concrete Buildings" called attention to the fact that proper attention is seldom given to the placing of electrical conduits and outlet boxes in concrete floors. I wish first to indorse this article, which holds architects and engineers responsible for the omission of proper detail in regard to type and location of conduits and the resultant tendency of the contractor to sacrifice either the adequacy of the conduits or the concrete reinforcement for the accommodation of both. I desire also to enter a further plea with special regard to telephone conduits and outlets.

Telephone service has undergone the same evolution as did electric-light service—from luxury to convenience and from convenience to necessity. The last step in this evolution, however, has been made much more recently in telephone service, and this may account for the apparent neglect of architects and engineers to incorporate in their

building plans and specifications provisions for an adequate and flexible system of conduits and outlet boxes for the accommodation of telephone cables and service wires. This omission, particularly in fireproof tile and concrete buildings, has been bringing the designer face to face with the problem of concealing the telephone wires after the completion of the building, which, if considered in advance and definitely incorporated in the building specifications, would have been comparatively simple.

In the case of a recently completed notable building the question of conduits for telephone service was not considered until after all contracts had been let and the foundation started. Upon the insistence of the telephone company the matter was given consideration, the requirements specified and the work of installing turned over to the contractor as an "extra," without definite locations for the conduits being assigned by the architects. Among the requirements was specified a 3-in. conduit in the basement floor, from the outer wall to the bottom of a column and up the column to the location of a switchboard. The contractor, without definite instructions, laid the conduit in the concrete floor with so many bends to avoid electric-light conduits, gas and water pipes and reinforcements that it was useless. He further waited for the construction of the column to install that part of the conduit and found the space occupied by other pipes and reinforcements which the designer, had he given the matter proper forethought, could have foretold. The walls being completed, it was then too late to choose an alternative location, and it became necessary to place the telephone cables in an exposed pipe crossing the basement ceiling. As the basement was to be used as a restaurant, this method was not desirable, and its adoption could have been prevented had the necessity been considered in the engineer's design.

I quote the above case, which is only one of a great many, in order to bring out the importance and the benefit alike to owner, designer, tenant and telephone company of giving the telephone conduits the attention which they deserve. An office building without telephone service is at the present time a place to be avoided by good tenants, and it is nearly as undesirable if the service is provided by running exposed cables through the halls, toilet rooms or other public places and fastening the wires on the outside of moldings, baseboards, doors, windows, etc.

R. D. GRAHAM,
District Engineer, New York Telephone Co.

Buffalo, N. Y., Jan. 15, 1916.

Oregon Water-Service Standards

Sir—After reading in your issue of Nov. 4, 1915, p. 885, the abstract of the rules of the Illinois Utilities Commission relating to standards of water service, I call to your attention Rule 28 as promulgated by the Oregon commission, for in speaking of the Illinois rules you state, "They do go beyond the Oregon rules, however, in the matter of interruptions to service."

During the winter of a year ago the largest utility supplying water under the jurisdiction of the Oregon commission did not maintain sufficient pressure at the end of its services to supply adequately each customer connected, with the result that service was interrupted for as much as a week in the higher levels of the city in question. Upon being given opportunity to show cause why the commission should not cite the failure to the proper legal officers for the exaction of the penalty contemplated by law, the officers of the utility agreed to refund to the injured customers a *pro rata* part of the monthly bill, the amount varying with the approximate time the customer was deprived of water. As this offer was satisfactory to the state and municipal officers, no further action was taken, it being considered that the utility had been subjected to a rather heavy penalty, which had been distributed among those who had suffered from the failure of the utility. It would appear that this concrete instance shows that, while the Oregon rules do not in so many words mention interruptions to service they are broad enough in their workings to cover interruptions to service.

E. W. MORELAND,
Engineer, Public Service Commission of Oregon.

Salem, Ore., Jan. 22, 1916.

[The Rule 28 cited by Mr. Moreland states: "Each water utility shall maintain sufficient pressure at the end of its services to supply adequately each customer connected, except customers who have specifically agreed to permit interruptions of service.—Editor.]

Granular Structure in Rivets

Sir—The following refers to your editorial on the failure of the Spokane bridge: In 1903 or 1904 a pin-connected bridge was being taken down on one of the branch lines of the Canadian Pacific Ry., because it was too light for the traffic, having been erected some 20 years before. As on other old bridges that were taken down, the men started to cut out the rivets with an ordinary cold-set, but found that they could do better work with a side-set, as used to cut out modern steel rivets. The heads of the old rivets flew off in exactly the same manner as those of the modern steel rivets.

The bridge men commented on this fact. While I admitted the difference in the cutting and the appearance of the break, I maintained that the rivets were of iron, which led to so much discussion that the bridge department asked for samples for a chemical analysis. These samples were broken from angle bars of about ½ in. thickness with a small blacksmith hammer that had been used for testing rivets, and only a few blows were required to break off a corner. In no case was it necessary to bend the metal through more than 90°. It broke off in exactly the same manner as zinc and showed the same granulated structure. The chemical analysis proved that the material was iron.

In the automobile trade it is well known that axles, drive shafts and crankshafts break under certain conditions, and the cause is ascribed to "crystallization" due to a knock in the engine or to imperfect lubrication.

CHARLES D. NORTON.

Sudbury, Ont., Jan. 22, 1916.

Water-Power Development in the West is hindered more by lack of a market for the power when developed than by the existing state and Federal restrictions according to the annual report of the chief of the Forest Service. The report says: "With rare and minor exceptions, existing power developments in the Western States are far in excess of market demands. The Forest Service is being constantly importuned to extend periods of construction on power permits on the plea that there would be no market available for the power if the project were developed."

Failure of the Lower Otay Dam

By Roy A. Silent*

SYNOPSIS—An unprecedented rainfall gave a runoff that overtopped this poorly designed and built rock-fill dam, dependent on a riveted steel-plate diaphragm for water tightness. In a few minutes the downstream portion of the rock fill melted away, then the steel diaphragm was torn from the top downward and the remainder of the dam opened like a pair of gates. A "wall of water" rushed 10 mi. down the valley in 48 min., causing the loss of at least 14 lives and property damage of $250,000.

The Lower Otay dam of the San Diego water-supply was completed in August, 1897, by the Southern California Mountain Water Co. and was subsequently acquired by the city. It was designed by, and constructed under the direction of, E. S. Babcock, at that time president of the company. It was located at the head of a rocky gorge 2 mi. in length. Above the dam the valley spreads out to a width of approximately half a mile and covers an area, when filled to the bottom of the spillway, of 859 acres. The bedrock at the dam site is a porphyry formation that is shattered and seamy.

It was originally planned to build the dam of masonry, and foundations were laid reaching a depth of 38 ft. below the zero contour and carried up to a height of 12 ft., where the top length was 85 ft. When the work had proceeded thus far, it was decided to change to a rock-fill dam with a steel core, or diaphragm, to render it water-tight.

The completed dam had a length of 565 ft. and a height of 130 ft., the crest being at a mean elevation of 482 ft. above sea level. It was originally planned to build the two faces of the dam on a slope of 2 to 1. This plan was changed, and the dam as constructed had face slopes of 1 to 1,[1] the top width being approximately 12 ft. Materials for the dam were taken from a quarry on the west side of the cañon, about 100 ft. below the dam. The major portion of the fill was loosened by the explosion of 12,000 lb. of powder. A second blast supplied sufficient rock to complete the dam. This material was placed by means of a Lidgerwood cableway.

PORTION OF STEEL CORE IN CANYON, HALF MILE BELOW DAMSITE

CANYON IMMEDIATELY BELOW DAM, SHOWING STRIPPING ACTION OF WATER

Riveted Sheet-Steel Plate for Watertightness

In the construction of the diaphragm an angle iron was anchored to the top of the masonry foundation by 1-in. bolts, the vertical member being punched with ⅝-in. rivet holes 3 in. c. to c., to which were attached the bottom of the plates forming the steel core. The plates were 5 ft. wide, 17½ ft. long and the three bottom courses 0.33 in. thick. Above 28 ft. high the plates were ¼ in. thick, and above 50 ft. they were 8 ft. wide and 20 ft. long. The steel core was carried to an elevation of 132 ft. above the zero contour. The plates were hot riveted. A single row of ⅝-in. rivets spaced 3 in. c. to c. were used.

The side of the diaphragm next the water was coated with hot asphalt and covered with a layer of burlap. A harder grade of asphalt was subsequently applied over the burlap, and the whole was then covered by a rubble concrete wall 2 ft. thick, with the steel plate in the center. The form boards consisted of 1x6-in. boards laid horizontally and backed by 2x6-in. posts. These forms were left in position. Owing to uneven expansion the steel core was not uniformly in the center of the concrete core wall, but it is understood that in all cases there was at least 6 in. of concrete between the steel and the outside of the wall. The core wall was carried into the side walls in a trench and anchored with bolts leaded into the bank.

The material forming the fill was allowed to lie as it was dumped into place. The amount of fine material in the fill, as shown by the examination after the failure, was much greater than had been ordinarily supposed. This fill was carried to a height of 133 ft. above the zero contour, or 3 ft. above the top of the core wall. Subsequent settling lowered this to an elevation of 132 ft., or 2 ft. above the top of the steel core wall, its position at the time of the failure. No effort was made to protect the lower face of the fill. On the water side a boom of logs chained together was used as a protection

*Engineering offices of J. B. Lippincott, Los Angeles, Calif.

[1]A letter from Allen Hazen, dated San Francisco, Feb. 9, states that after study of his photographs of Oct. 27, 1915 (see "Engineering News," Feb. 3, 1916), he thinks a slope of 1¼ to 1 is more nearly correct than 1 to 1.—Editor.

against wave action. (See Fig. 5, p. 238, *Engineering News* of Feb. 3.)

The spillway, built of concrete, is located on the east bank and has a width of 37.9 ft. at the bottom and 41.5 ft. at the top. The depth is 8 ft. It has a uniform slope of 0.00365. The capacity when running full is approximately 2,400 sec.-ft., after allowing for entry and velocity heads. The reservoir has a tributary drainage area of 139 sq.mi, and there are published records of flood discharges of 100 sec.-ft. per sq.mi. in the adjoining Sweetwater drainage basin.

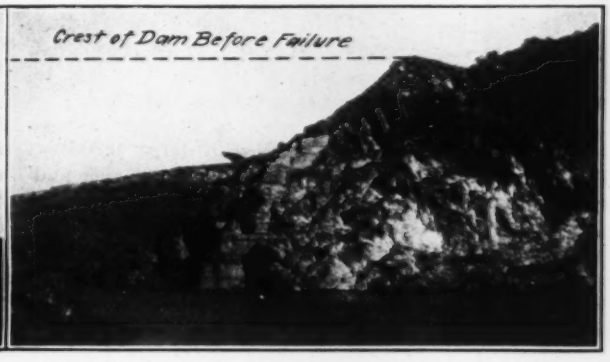
There is no blowoff provision from the reservoir, except through the outlet tunnel, which is 48 ft. above the zero contour. This tunnel is 1,150 ft. long, driven through a hardpan and cemented-gravel material. At the lower end of the tunnel there is a Y-connection, at which there is a 48-in. blowoff gate valve. The estimated maximum discharge of this blowoff, with a head of water to the bottom of the spillway, is approximately 400 sec.-ft. Until the recent flood the water had never been higher than 15 ft. below the bottom of the spillway. A small leak in the dam discharged approximately 25 miner's inches. This water was pumped back to the reservoir by a pump located at the foot of the dam.

The storm that caused the failure of this dam was unprecedented in the history of San Diego. The mean total annual rainfall for a 65-yr. period is 9.57 in. at San Diego; the mean for the same period for the month of January is 1.84 in. The total rainfall to date this season is 10.89 in. From Jan. 15 to 20 there was registered at the dam 5.60 in. of rain. No particular damage to the countryside resulted from this rain. From Jan. 20 to 24 inclusive there was no rain. On Jan. 25, 26 and 27 there was 3.54 in. of rainfall at the dam. On Jan. 27 the United States Weather Bureau gage at San Diego registered 2.19 in. This rain did great damage, destroying practically all the bridges in the county, rendering many families homeless and flooding and inundating considerable areas, in addition to the loss of life and destruction of property caused by the failure of the dam.

Prior to Jan. 15 the water surface in the Otay reservoir was 96.5 ft. above zero contour. From Jan. 16 to 21 at 7 a.m. it had risen 11.8 ft. to a height of 122 ft. 8 in. At this time, water began to run over the spillway. From Jan. 21 on, the level continued to rise in spite of the discharge through the spillway. On the morning of Jan. 27 the reservoir was at 124 ft. 9 in., and the spillway was probably discharging in the neighborhood of 1,500 sec.-ft.

The rain on Jan. 27 was extremely heavy, and by noon the water had risen so high that Mr. Weuste, in charge at the dam, deemed it advisable to open the outlet gate. This failed to check the rise, and it was realized that the dam would probably be overtopped before evening.

WEST ABUTMENT, SHOWING REMAINS OF STEEL CORE WALL



EAST ABUTMENT, SHOWING REMAINS OF CORE WALL

Men were accordingly dispatched to warn residents in the valley to move to higher ground. Word to this effect was also sent out from the telephone exchange at National City. Most of the inhabitants took advantage of this warning.

At 4:45 p.m. the water had reached the top of the dam and had seeped through and filled the boxes that were sunk in the top to allow an examination of the steel core. Water began running down the lower face on the east side of the dam at approximately 4:50 p.m. About this time several spouts or small streams of water appeared on the lower face of the dam, in one instance loosening a large boulder which rolled down to the bottom. From this time on, the destruction was very rapid. The lower face of the fill quickly melted away, thus removing the support from the core wall. At 5:05 p.m. the tension was so great that the steel diaphragm tore from the top at the center, and the dam opened outward like a pair of gates. The released water rushed through and filled the cañon to a point approximately 20 ft. below the top of the dam. The draw-down area extended possibly 200 ft. behind the dam. It required 2½ hr. for the reservoir to empty.

A huge wall of water, variously described as from 6 to 20 ft. high, rushed down the valley, covering the distance from the damsite to Palm City, about 10 mi., in 48 min., carrying all before it. The total loss of life has amounted to 14 at the present writing (Feb. 8), but there are still several persons missing. The property damage is estimated at $250,000.

Examination of Damsite and Valley Below

A thorough examination of the damsite was made on Jan. 31 and Feb. 1. Practically all the fill was washed completely away. The steel core was deposited in varying-sized sections along the valley, a large part being found at Palm City, 10 mi. below the dam. The core wall had torn itself loose from both of the side walls, as shown in the accompanying photographs, the foundations remaining intact. An examination of the bottom was im-

possible, as water to a depth of 8 ft. was flowing through a constricted channel in the bottom of the cañon.

Three-quarters of a mile below where the dam had stood a piece of the diaphragm was observed, to which the angle iron forming the bottom of the steel plate was riveted, showing that the extreme bottom had been torn loose. On the west side behind the remaining core wall was a small part of the fill, composed of rock of small sizes, none of which was over 1½ ft. in diameter, and grading from that to coarse gravel. If this may be considered a fair sample of the remainder of the fill, it is easy to understand its melting away as rapidly as described.

The cañon below the dam, prior to the failure, was considerably restricted and filled with large boulders. The action of the water removed all the loose rock and thoroughly stripped to bedrock both sides of the cañon as high as the water reached, the line of demarcation being clearly defined. The stripping was done in a most thorough manner, no particle of soil remaining in any of the niches or crevasses. This area was heavily wooded with brush.

An interesting feature was observed in that for half a mile below the dam in practically every pocket or niche in the rock was to be found a rivet head. An examination of the remaining parts of the steel core showed it to be in a perfect state of preservation, no rust or corrosion being noticeable. The destruction of the plate had taken place for the most part along the riveted seams, though one or two cases in which the sheets had torn were observed.

The reservoir above the dam showed a deposit of silt to a depth of from 5 to 6 ft. in most places, through which the present flow of the river is cutting a channel. The amount of silt deposited cannot be taken as a fair average for reservoirs in this section of the country, as much of the water passing into the reservoir was carried by a conduit and was comparatively clear.

Ohio Engineers Discuss Roads

Roads were the dominating subject at the annual meeting of the Ohio Engineering Society, Feb. 9 to 11, 1916, at Columbus. County surveyors, who form a large part of the membership of the society, made up the bulk of the attendance. The welcoming address of W. O. Thompson, president of Ohio State University, early introduced the road question by referring to the absence of records of road-building methods and the lack of experimental knowledge of road endurance. He advocated a state road-testing laboratory.

That the society is in a period of active growth is due in part to the effect of the recent Cass highway law in bettering the compensation of county surveyors. The legislative committee of the society helped put this law into the statutes of the state, and one result of this action is a considerable increase of county surveyors in the membership. However, the society includes many private and corporation engineers. There is promise that the representation of this part of the profession will grow and that the program of next year's meeting will correspondingly cover engineering subjects other than roads.

By laying the brick road surfacing on the foundation concrete while the latter is still green and unset—that is, within a few minutes after placing and screeding the concrete—the town of Paris, Ill., last year made a sharp divergence from established brick-road building practice. M. B. Greenough, instructor Case School of Applied Science, Cleveland, Ohio, in describing the Paris procedure, put these roads in a class by themselves as "monolithic" brick pavements, while he used the term "semimonolithic" to describe brick pavements laid on a dry cement-and-sand cushion coat spread on top of a hardened concrete foundation.

"Monolithic" Brick Pavements

The essential tool used in the Paris construction is a double templet, or screed, which strikes off the foundation concrete and also spreads and evens a cement-and-sand intermediate layer, called the luting layer. The templet consists of a 6-in. I-beam transverse to the road as front edge, and a channel 2 or 3 ft. back of the I-beam as rear edge. The templet slides on top of steel side forms or temporary curbs; it is hauled forward by a drum on the concrete mixer. The space between the I-beam and the channel is filled with dry sand and cement. The channel is set so that its bottom is about $\frac{3}{16}$ in. higher than the bottom of the I-beam. When the templet is pulled forward, it screeds off the top of the concrete placed ahead of it and then covers the concrete with a thin layer of sand and cement.

This luting layer fills all irregularities in the surface of the concrete and forms a smooth bed for the brick. The bricks are laid close behind the templet. As the luting layer is on fresh concrete, it quickly absorbs enough water to form a stiff mortar, bedding the brick and cementing them down. Rolling with a light hand roller and grouting next day finish the pavement. The surface obtained is reported to be unusually even.

D. Moomaw, Cuyahoga County road engineer, advanced some original ideas in discussion. Aiming at real monolithic construction, he disapproves of the dry sand-and-cement course and holds that a well-mixed mortar should be used. The concrete base should have a deficiency rather than an excess of coarse aggregate, so that ramming will bring mortar to the surface to constitute the bonding course. He also disapproves of omitting the concrete edging. In Cuyahoga County the edging, made monolithic with the foundation, is cheaper per unit of pavement surface than the brick.

Concrete-Road Development in Lake County

During successive years concrete-road construction in Lake County has gone through a regular development. H. P. Cumings, county surveyor, Painesville, gave a detailed record of the work, with prices, and indicated several conclusions from experience with the finished pavements.

The most recent deduction is that reinforcement is the only means of preventing cracking. In several roads contiguous pieces of reinforced and unreinforced work showed cracking in most of the unreinforced blocks, the cracks stopping at reinforced blocks in all cases. Blocks of 33 ft. are the regular practice. Armored joints are preferred. Difficulties were experienced at times with poor sand in the concrete.

County and township duties in getting in shape the earth, gravel and macadam local roads were discussed in two strong addresses. F. M. Kennedy, of Washington, Ohio, spoke to the title "Coöperation the Keynote in the Expenditure of the Two-Mill Levy." Jesse Taylor, presi-

dent of the Ohio Good Roads Federation, spoke on "Maintenance and Repair." The main theme of both speakers was the need of systematic attention to the minor roads, unimproved and partly improved. The great extent of road improvement under the state-aid laws is apt to bring about neglect of the minor roads, to the disadvantage of the local population.

Mr. Taylor, referring to the likelihood that some county surveyors may neglect road-maintenance work in favor of work that yields special compensation, went so far as to forecast amendment of the Cass law by the next legislature in the direction of reducing the compensation of county surveyors.

Other papers on road subjects were: "Glutrin as a Binder," by C. J. Knisely; "The Penetration Method of Building Bituminous Roads," by H. B. Stone; "Road Legislation," by Senator Charles C. Cass; "The Ohio State Highway Department," by Clinton Cowen; and "Does a Material Salesman Ever Coerce the Public Officials or the Contractors?" by F. W. Patterson.

Questions in Flood Protection and Conservancy

A bold attack on the present method of handling flood protection in Ohio (under the conservancy law) was made by Prof. C. E. Sherman, dean of civil engineering, Ohio State University, Columbus. His address, entitled "Some Phases of Conservancy Engineering," followed the general lines of the elaborate monograph which he recently published, "The Ohio Water Problem," Ohio State University Bulletin, November, 1915. The speaker asserted that flood-protection work, planned for a half-century emergency, must also take care of the next half-century's needs as to rivers. Water-supply, power and transportation are chief among these needs, and the conservancy law as hitherto interpreted neglects them entirely. The scarcity of water-supply sources for the interior cities of the state is a problem even today, and the search for water becomes more difficult each year.

That water transportation will be very important in the future was discussed rather fully by the speaker. The basal point of this discussion was the statement that present transportation agencies have reached the limit of their possibilities in carrying low-grade freight and that water routes will allow cheaper movement of bulk freight.

A series of pictures was displayed to show the great efficiency of sod in preventing flood scour. Various experiences in Columbus during the great 1913 flood proved the protective value of sod. Even narrow strips acted as perfect protection to the soil below, although macadam roadways were completely washed out close alongside.

Several papers of general engineering interest were presented: E. G. Bradbury on the new Akron water system; G. H. Charls on "pure" iron ("Armco" metal); D. B. Luten on concrete arch bridges; J. M. Vance on bridge paints; W. A. Stinchcomb on the Cleveland viaducts; Prof. T. J. Smull on engineering failures; and C. L. Bushey on drainage legislation.

The meeting was held at the Ohio State University, as was that of last year. A dinner at the students' club house, the Ohio Union, was a feature of the gathering. The support of the university was recognized in the election of Prof. Clyde T. Morris as president of the society for the coming year. A. R. Taylor was elected vice-president. John Laylin, of Norwalk, was reëlected secretary and treasurer.

Minnesota Engineers Meet

A large and interested gathering of both local and out-of-town engineers marked the twenty-first annual meeting of the Minnesota Surveyors and Engineers' Society, held at St. Paul, Minn., Feb. 10 to 12. One session was held jointly with the Civil Engineers' Society of St. Paul, and one evening the state society met with the Minnesota section of the American Society of Mechanical Engineers to hear an address on the manufacture of portland cement by Geo. P. Dickmann, chief chemist of the Northwestern States Portland Cement Co.

Two special addresses were those on "The Relations Between the Architect and the Engineer," by W. C. Armstrong, chief engineer of the St. Paul Union Station Co., and "Public Duties of an Engineering Society," by F. H. Newell, head of the civil-engineering department of the University of Illinois. This latter address followed the annual dinner, in which the Engineers' Club of Minneapolis and the Engineers' Society of St. Paul participated.

Drainage and road construction were prominent topics. A paper on "Drainage Surveying," by J. E. Cole, county engineer, Morris, Minn., referred to the unsatisfactory method of assessing benefits for drainage where there are such large variations in benefits derived. In the discussion, stress was laid upon the fact that lawyers and judges have little or no understanding of the technical features of drainage work or surveys—a fact that accounts for many unsatisfactory decisions in regard to assessments. Prof. John T. Stewart, State Agricultural College, dealt with drainage engineering. A great amount of drainage work is being done, and there are immense possibilities; but a good part of the earlier work has been done without proper engineering investigation or supervision, and the unsatisfactory results have led to unfavorable opinions in the rural districts. It is for the engineer to educate the public mind in this direction as well as to carry out the strictly engineering work.

Papers on roads, by three engineers of the State Highway Commission, dealt with road work by contract and by county forces and gave the comparative cost of hauling by tractors and by teams. Two papers presented the special problems of streets in hilly towns. One related to sidewalks and curbs on steep streets and sidehill streets, and the other to the conditions at street intersections. Street sprinkling by city forces at Rochester, Minn., was described by J. C. Utton, city engineer. The work proved to be cheaper than by contract, and a notable result was that complaints practically ceased.

In relation to water-supply and sewerage work the Committee on Municipal Affairs pointed out that construction and maintenance of water-supply systems are often without proper engineering supervision, and that in many cases the installation of water filters is the result of enterprising salesmanship rather than scientific investigation of a sanitary problem. For wells it suggested also the advisability of making a watertight joint between the well casing and the drop pipe as a sanitary precaution, although this is rarely done. In the past, sanitation has been considered largely a matter for the medical profession; but the engineer is probably better qualified to deal with such problems, and the two professions might coöperate more in future, with great benefit to the public.

A resolution was adopted opposing the proposition of the Minnesota League of Municipalities to ask the legislature to authorize and make appropriations for an engineering staff of the University Extension Division to furnish advice to municipalities in regard to public utilities. This plan is considered unnecessary, since it would duplicate work already covered by the State Board of Health and the State Highway Commission.

The officers for 1916 are as follows: President, F. W. McKellip, city engineer, Baraboo, Wis.; vice-president, B. J. Reynolds, drainage engineer, Redwood Falls, Minn.; secretary and treasurer, W. F. Rosenwald, State Highway Commission, St. Paul, Minn.

Judge Anderson's Decision on the Bone Retaining Wall

In the case of Frank A. Bone against the Board of Commissioners of Marion County, Indiana, for the infringement of United States Patent No. 705,732 on a reinforced-concrete retaining wall, Judge A. B. Anderson, on Jan. 26, 1916, rendered an oral opinion dismissing the bill for want of equity. The Bone retaining-wall case was fully discussed in *Engineering News*, Feb. 10, 1916, p. 254. To complete the record, Judge Anderson's decision is reprinted in full herewith:

IN THE DISTRICT COURT OF THE UNITED STATES,
FOR THE DISTRICT OF INDIANA

Frank A. Bone
vs.
Board of Commissioners of Marion County, Indiana, et al. } No. 7293, In Equity

Now, when I started into the hearing of this case and it was stated to me that the Circuit Court of Appeals of the Sixth Circuit had upheld this patent and had found infringement, I thought that the defendant would have a very serious time in attempting to get this court to differ from that court. I believe that if the question were doubtful, this court ought, in the interest of the proper administration of justice and the protection of the rights on both sides, if possible, agree with the court which had passed upon it before. But it is perfectly evident to my mind that the very foundation of the decision of the Circuit Court of Appeals, as well as the foundation of the decision of the district court from which that case was appealed, was wrong; the very foundation of it was wrong. Gentlemen may go out from here with the absolute conviction that the court as constituted here did not understand this case; but I am very firmly convinced either that the matter was not fully presented to the district judge in Cleveland and that the record was not as fully made up in the Court of Appeals as it is here, or at least that they did not understand it—one or the other.

Now this man has set out here what his invention consists in. I notice that where a plaintiff has not a very clear ground to stand upon, it is pretty hard to get him to tell just what the invention consists of, and frequently I must go back to the patent to see what it means. Now it is stated here:

My invention relates to improvements in retaining walls for abutments of bridges, sea walls, banks of streams, embankments, cuts, dams, dry docks and such places as it is desired to retain earth or other matter permanently in place with its face at an angle nearer vertical than it would naturally repose when exposed to the action of the elements or gravity.

This is to what his invention relates:

The said invention consists principally of introducing into masonry of concrete, stone or brick a framework of steel or iron in such a way that the whole wall is so much strengthened thereby that the volume of the masonry may be greatly reduced, and yet the height, base and strength against overturning, bulging or settling will still be ample.

Then he says further:

The object (stability with reduced volume) is further accomplished by the peculiar shape of the cross-section of the wall allowable.

Of course, that is true. Anybody could see that. Any boy who worked with mud could see that if you made the top of a wall three feet and the bottom two feet thick, it would not be as strong as if the proportions were reversed. So a man cannot predicate invention upon the peculiar shape of the cross-section of the wall.

Now, this case went before Judge Day, and what [illegible] he decide? Unfortunately for these gentlemen, the reas[illegible] are put in writing, and I see the judge's name is signed to [illegible]

The invention claimed relates to retaining walls or [illegible]lar structures designed to retain earth or other matter in place with its face at an angle near vertical—

he means nearer vertical—

than it would naturally maintain as affected by the [illegible] of gravity and the action of the elements, and the invention consists in embedding in retaining walls of concrete, stone or brick a frame or skeleton of metal arranged in certain relations to the stresses which the wall is required to withstand.

Now, anybody who understands the reinforcement of concrete knows that from the very beginning of that art the metal was arranged in certain relations to the stresses that the wall was required to withstand. That ought to be so.

The object is to obtain ample resistance to breaking, bulging, overturning or settling with a smaller volume of masonry than would be required for the ordinary gravity wall of equal strength and stability.

The object of every wall builder is to get the required or desired degree of strength with less masonry.

The patent describes and illustrates a concrete wall consisting of a thin vertical wall having an extended heel and toe reinforced in the upright portion by upright metallic members at the back part of the wall, and in the heel by metallic members extending obliquely along the upper part and in the toe by metallic members extending transversely along the bottom. The reinforcing members are placed near the back face of the wall and heel and nearer the lower face of the toe. . . .

This wall described by the patent uses the weight of the retained material to retain itself; while in the gravity wall, which was old in the prior art, the resistance to overturning is the wall itself.

Then going on further:

Considering the claims of the patent, and the testimony, I am of the opinion that Bone, the patentee, was the first to reinforce the retaining wall or similar wall of concrete or masonry in such a manner that the weight of the retained material would be utilized to impart through the reinforcing members tensile resistance to the stern or vertical part of the wall, thereby fortifying this part of the wall against breaking strains.

And we now know in the light of the evidence in this case that Bone was not the first to reinforce the retaining wall in such manner that the weight of the retained material would be utilized to impart through the reinforcing members tensile resistance. He was not the first person to reinforce a retaining wall; he was not the first to conceive the idea of a reinforced retaining wall which was so shaped and constructed that the weight of the earth on the heel of the wall would withstand the pressure of the dirt or the earth on the wall. He was not the first to do it. If there is anything that is absolutely demonstrated by the evidence in this case, he was not the first to do what Judge Day says he was the first to do, and upon that he predicates his opinion. Now it may be that upon the record before Judge Day, Bone was the first person to do that. So far as the record in this case is concerned, the absolute converse of that proposition has been demonstrated.

In the decision of that case in the Circuit Court of Appeals for the Sixth Circuit the claims involved are the same as in this case, plus claim No. 2. There the claims were 1, 2, 3, 5, 16 and 17. Now, let us look at the decision:

In the present more or less familiar state of the reinforced-concrete art the impression is natural that there cannot be patentability in the structure of these claims; but the patent was issued upon an application filed in 1899, which was a renewal of an application in 1898, and Mr. Bone's idea is shown to have antedated his application.

How far it antedates it, there is not anything here to show.

We are thus carried back nearly 20 years. The record discloses nothing anticipating the substantial thought of the patent.

Now, what is the substantial thought of the patent?

The said invention consists principally of introducing into masonry of concrete, stone or brick a framework of steel or iron in such a way that the whole wall is so much strengthened thereby that the volume of the masonry may be greatly reduced, and yet the height, base and strength against overturning, bulging or settling will still be ample.

The record in this case shows a number of things to anticipate that substantial thought. The court goes on and evidently had in mind the distinction between a gravity wall and this wall:

Masonry or concrete retaining walls were deep and heavy, and maintained by gravity in their resistance against a horizontal stress. There was no occasion for reinforcement. Sustaining walls had been built of concrete with vertical reinforcement; but they were maintained against side strain by crossties or beams, without which they might tip over. If the prior art had shown a structure intended for a retaining wall and having a heel such that the weight of the earth thereon would tend to keep the wall erect, it might be difficult to find invention in merely adding the form of reinforcement most suitable to create the desired tensile strength; but we find no such earlier structures.

Now the evidence in this case shows a number of such earlier structures, and so the very foundation of this opinion

taken away by the evidence in this case, assuming that the decision was based upon the record as it was there.

On the application for a rehearing, where the court declined to direct the court below to open the case to permit the defendant below to put in a certain German patent after deciding that there was no satisfactory excuse for not producing the proof in due time, the court went on and said:

While the new reference (if it passed the limits of mere suggestion or unsuccessful experiment) would be distinctly pertinent upon the issue of invention, and if properly proved in another case should receive careful consideration, it is not so demonstrative of error in the result already reached as to require its reception.

So the court did not have before it the evidence either on the petition for a rehearing or on the original hearing, that this court has on the state of the prior art.

There is shown here beyond any question whatever retaining walls, anticipations of retaining walls, publications and descriptions of them which are of the cantilever type. One where the vertical bar is held in a vertical position by the weight of the earth upon the horizontal part of it, or the heel of it held by the weight of the earth which is to be retained, and those various retaining walls of that kind, operating in that way, are shown to be reinforced in various ways. So far as the shapes are concerned, they use various diversified shapes that are shown by this patentee. Take one of these exhibits which has the counterfort form. Take this model, for example. There is foreshadowed the very idea of the slant up. The character of the top there is the same, or it may be carried to a place not so near the top, and if this is a correct representation of the patent, the model here discloses it in detail.

When we come to the Stowell and Cunningham device, I cannot see how that is not a complete anticipation of everything this man did except it be that his patent is to be limited to the particular form which he shows for his framework. There is a retaining wall of concrete, with a framework of steel or iron, introduced into the concrete in such a way that the whole wall is much strengthened, and so much strengthened that the amount of material is much reduced. There is the model. How could any court understand this art, and understand what the patentee claims, and understand the Stowell and Cunningham patent and find that it does not anticipate, is beyond my comprehension.

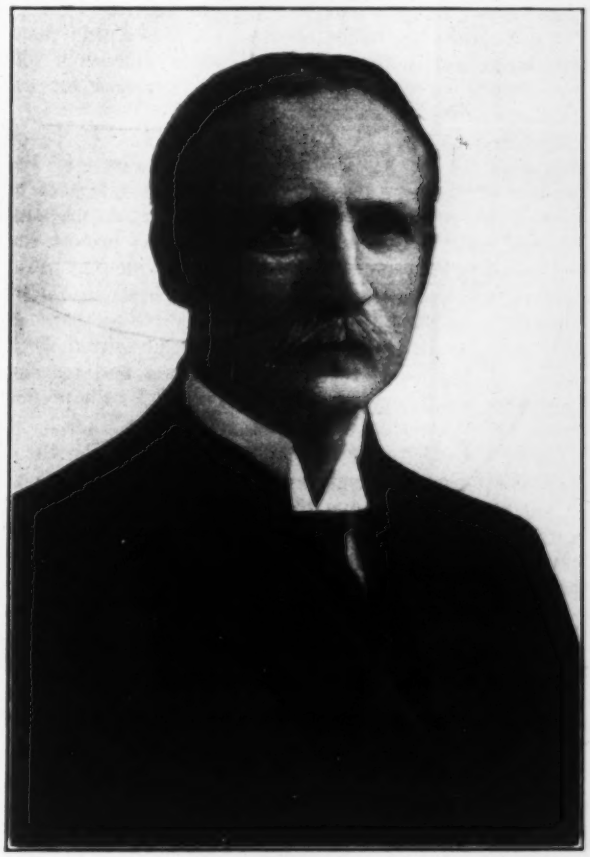
I assume that this Stowell and Cunningham patent was in some of these cases, but it is not necessary for me to hold that this patent is invalid in order to come to the conclusion, or reach the conclusion that I have to reach in this case. It may be valid, but if so, I do not think much can be said on that theory. If so, the only thing this man did was to devise a framework and embed it in concrete, and if you want to carry it forward, there is the method in which it should be embedded, in the sense that it was a framework put up first and the concrete poured in afterward. Now, I think it is going a long way to assert that what the defendants did is an infringement of this patent on either ground; and inasmuch as I am a mere examining magistrate and inasmuch as the defeated party usually thinks that the trial court knows nothing about it and that he will go to a court that does understand it, I will dismiss this bill for want of equity. The record will show the bill dismissed for want of equity.

New President of the Canadian Society of Civil Engineers

George Eric Duggan was born in Toronto, Canada, in 1862 and was educated at Upper Canada College, Toronto, and at the School of Practical Science, Toronto University. In 1884 he joined the Canadian Pacific Ry. and was assigned to location work on the mountain division. He remained with the railway until the end of 1885, before which time he had been assigned to the drawing office and placed in charge of the division of bridge erection and of a section of grading.

In January, 1886, he entered the drawing office of the Dominion Bridge Co.—of which thirty years later he became General Manager—becoming Chief Draftsman in 1889 and Chief Engineer in 1891, which position he held until the end of 1901. During this period the company erected a number of Canadian bridges, including the first Coteau bridge, the Grand Narrows and St. Mary's River bridges, the Inter-Provincial bridge at Ottawa, the swingbridge and the emergency dam at Sault Ste. Marie, Ont., as well as the first Canadian hydraulic lift-lock, on the Trent Canal, at Peterboro, a structure still cited as a model in its field.

He went to Sydney, N. S., in January, 1902, to become assistant to the president of the Dominion Iron and Steel Co. and of the Dominion Coal Co. A considerable amount of civil-engineering work was then being prosecuted by both companies, and Mr. Duggan was placed in charge of it. In 1907 he became Third Vice-President of both companies, and in 1905, when the companies separated, he was appointed Second Vice-President and General Manager of the Dominion Coal Co., remaining in that capacity until 1910. He was responsible for the engineering work of the Dominion Coal Co. and for the opening of a number of new mines, the construction of



GEORGE ERIC DUGGAN

docks and unloading plants and the extension and operation of the company's railway service.

In 1910 Mr. Duggan returned to the Dominion Bridge Co. as Chief Engineer, in which capacity he was responsible for the preparation of the design for the new Quebec Bridge, for which tenders were being prepared at the time he became Chief Engineer. In 1912 he was appointed Vice-President and General Manager of the Dominion Bridge Co. and Chief Engineer of the St. Lawrence Bridge Co., a company which formed to bid on the superstructure of the new Quebec Bridge and which was awarded that contract. He has continued actively since then in the great work of building this bridge.

News of the Engineering World

Military-Engineering Lectures Draw Big Crowds

The series of lectures on military engineering, started Feb. 14 in New York City under the auspices of a committee of the national societies of civil, mechanical, mining and electrical engineers, drew out a crowd that far exceeded the dreams of the promoters. The advance registration was so heavy that ticket admission was put on and a parallel session arranged. The main auditorium of the Engineering Societies' Building was filled; there were about 500 in the small auditorium, and some 700 were turned away. The lectures will continue for six Monday evenings.

The first lecture, by Capt. T. M. Robins, Corps of Engineers, U. S. A., was a general exposition of the function of engineer troops, with particular reference to services for which civilian engineers might prepare. Summed up, the duties of this force are to protect the line troops by equipment and works, to provide maximum comfort, to construct and operate transportation facilities, and—not the least—to engage in active combat. A complete military training was held up as essential, both because of the necessity of active fighting and for the knowledge of military requirements needed for the proper course of engineering operations.

Under the existing American army organization there are five battalions of engineers for each army division of 60,000 men. In Europe the ratio of engineers to infantry is 6%—double that here. If a trained force of 500,000 men was decided on for defense in this country, there would have to be about 1,200 officers, 8,000 noncommissioned officers and 28,000 enlisted engineers. Officers and noncoms., it was said, would have to be good technical men with adequate military training. There are now 248 engineer officers and 19,000 troops in the regular army, with 60 officers and 1,500 men in the National Guard.

Captain Robins described the work of the army engineer in action as having very few of the ordinary construction and municipal features. However, it is essentially only the engineering of civil life adapted to military necessities. The activities of all sorts of engineers are embraced in surveying, mapping, reconnoissance, trenching, tunneling, mining, sapping, lighting camps and battlefields, building and maintaining coast fortifications, keeping telephone, telegraph and wireless communication open (the work of the signal corps rather than the engineer troops), field bridge building, maintaining roads and bridges between railway heads and troops in the front line, construction and operation of railways in the danger zone, etc. The younger and more vigorous men would belong to the pioneer and pontoon field forces, while the older men might be expected to serve in the seacoast fortifications, along the lines of communication, on interior defensive works and on supply-depot and material-inspection details. For every such work adequate military training is an essential accompaniment of technical ability.

The remaining lectures will be by Capts. E. D. Ardery, R. T. Coiner and T. M. Robins, Corps of Engineers, U. S. A., and will take up more in detail: (1) Reconnoissance, mapping, surveying, photography; (2) field fortifications, sieges and demolitions; (3) sea-coast defenses and battlefield illumination; (4) roads, bridges, ferries, and fords; (5) camps and cantonments, general construction, public engineering works of a military nature; (6) railways under military control.

Electrical Engineers Studying Institute's Functions

What is the proper function of the American Institute of Electrical Engineers? Does the rapid increase in technical knowledge and the increase in the number of specialists demand a readjustment of the society's organization and activities? Such were the questions propounded to the membership at the midwinter convention in New York on Feb. 8 by the paper of D. B. Rushmore, "The Institute and the Technical Committees."

For many years the institute had no technical committees at all; now it has 14—on power stations, transmission, railways, protective apparatus, lighting, telegraphy and telephony, marine work, electrochemistry, electrophysics, industrial power, records and appraisals, education, mining and the iron and steel industry. These committees have not been established in accordance with any general plan and do not subdivide the field of electrical engineering as was done in connection with the recent International Electrical Congress.

It was reported that the institute could not on present lines continue to supply the needs of the members for information along their special lines and that some modification must be brought about or there would be an increasing number of auxiliary societies of special interest. Twenty-eight societies were named as duplicating the work of the institute in part.

Some of the other important questions involved were as to the desirability of technical committees developing engineering handbooks on particular fields; the presentation of annual reports from technical committees outlining the special developments of the year in the several fields; the development of technical sections within the institute along lines of distinct division; bringing back to the institute a special organization covering special divisions of the electrical field; the possibility of a central organization wherein all engineering societies could be brought together; the definition of activities of the several engineering societies now overlapping; proper and permanent relationships between the institute and commercial organizations like the electric-light and railway associations. The paper presented no plan, made no arguments for particular plans, but stopped with the presentation of the problem.

The discussion showed the widest possible range of views, some holding that the institute should confine itself to the more scientific aspects, while others would make the institute's topics as broad as possible; some saw no danger in encouraging special societies. The president, J. J. Carty, reported that there were no data at all on present conditions or on the desires of the members, so that the problem could not yet be well defined. He urged the collection of data, just as in taking up any engineering problem.

Illuminating Engineers Hold Tenth-Year Celebration

The midwinter convention of the Illuminating Engineering Society, held at New York City, Feb. 10 and 11, was made a celebration of the tenth year in the life of the society. The opening session was devoted to a series of notable addresses by Hon. J. P. Mitchel, mayor of New York City; Dr. A. E. Kennelly, of Harvard University; Dr. C. C. Steinmetz, president of the society, of Schenectady; L. B. Marks, the first president of the society, of New York City; Prof. Hugo Muensterberg, psychologist, of Harvard University; C. R. Lamb, architect, of New York City; and Dr. F. P. Lewis, physiologist, of Buffalo.

These addresses reviewed progress in the many fields which improved lighting touches. Mr. Marks, in a historical review, showed how the membership had increased to over 1,500 in 10 yr., gathering in a harmonious aggregation electrical and gas engineers, architects, decorators, fixture designers and manufacturers, physiologists and psychologists. The society has printed some 8,000 pages of proceedings, covering all phases of the science and art of good lighting.

A notable feature of the convention was a banquet at which honorary membership was conferred on Thomas A. Edison. One evening session was given up to a lecture by W. d'A. Ryan, of Schenectady, the designer of the lighting features of the Panama-Pacific Exposition. A technical program was also presented.

ENGINEERING SCHOOLS

Ohio State University

Research professorships are to be established, according to a recent vote of the board of trustees on a suggestion of President W. O. Thompson. The research professors will be relieved of all, or nearly all, instruction duties and will follow research work in their special subjects for the benefit of the state. To begin with, five or six such professorships may be established, probably including one or two in engineering.

Ohio State University

A new postgraduate course in Public Health and Sanitation has been incorporated in the courses of study of the Ohio State University. The aim of the study is to prepare young men and women for public-health work in Ohio and elsewhere; to fit them to occupy positions as health officers, members of boards of health, secretaries, agents, or inspectors of health organizations, either official or voluntary. To do this, it is planned to give a groundwork of sanitary knowledge by instruction in the laboratories and by lectures.

University of Knoxville

The department of engineering has prepared a correspondence course in highway and bridge construction for county engineers. The course consists of 20 lessons, prepared by Prof. Corphul Fergus, and is supervised by Prof. Charles E. Ferris.

NOTES

A Conflagration in Bergen, Norway, destroyed a third of that seaport on the night of Jan. 16. The property damage is estimated at $15,000,000. The section of the city destroyed includes the business section, several hotels, a number of schools, the electric-lighting plant, etc.

Plans for Water-Works Improvement at Aberdeen, Wash., to cost about $100,000, are being made by L. D. Kelsey, city engineer. It is expected that there will be a 40-in. wood-stave supply conduit, that bids for this and the head works will be received during the coming spring and that the construction of this part nearly completed during 1916.

Alabama Water-Power Condemnation Statutes were declared constitutional by the United States Supreme Court on Jan. 24. The suit was brought by the Alabama Interstate Power Co., of Birmingham, to condemn certain lands on the Tallapoosa River. Justice Holmes stated that the objection that the purpose is not a public one is not valid, because "to gather the streams from waste" in order to produce and sell power is a public benefit.

The False Block-Signal Indication that caused the collision of a passenger and a freight train on the Nashville, Chattanooga & St. Louis Ry. near Cowan, Tenn., on Dec. 23, 1915 (see "Engineering News," Jan. 6, 1916, p. 45), has been investigated by the Division of Safety, Interstate Commerce Commission. A report has just been made by H. W. Belnap. At the point of the accident there is a siding controlled by electric three-position block signals. The parallel Western Union telegraph lines and the signal wires were being moved. A grounded signal wire and a cross with the telegraph lines are charged with responsibility for the foreign current that held the signal falsely at "clear." This is the first such accident reported to the commission.

A Bronze Memorial Tablet of the late George Westinghouse, founder of the numerous industries bearing his name, was presented to the Westinghouse Electric and Manufacturing Co. by the Veteran Employees' Association of that company at its third annual banquet, held on Jan. 29 in the Fort Pitt Hotel, Pittsburgh. This organization is three years old and is composed of men who have been in the employ of the company for 20 years or longer. About 450 were present at the banquet. President I. De Kaiser made the opening address and introduced the toastmaster, John E. Bonham. The memorial tablet is approximately 4x3 ft., made of solid cast bronze, and weighs 300 lb. It shows a true bas-relief likeness of Mr. Westinghouse and bears the inscription, "George Westinghouse, Master Workman, Inventor, Founder, Organizer, 1846-1914." It will be placed in the reception room of the East Pittsburgh works of the company.

Admission to an Engineering Society as a legal right was involved in a suit just decided in New York City. Nora Stanton Blatch brought suit against the American Society of Civil Engineers to compel her admission to the grade of associate member. Mrs. Blatch is a graduate from the civil-engineering course of Cornell University and was admitted to the society as a junior in 1906. Under the society's constitution a junior reaching the age of 32 years ceases connection with the society unless he has been previously transferred to a higher grade. According to the brief submitted by the attorney for the plaintiff, Roger Foster, Mrs. Blatch applied in 1912 for transfer to the grade of associate member, but her application was rejected, a resolution of the board being cited in connection with the application of another woman for admission to the society, in which the board expressed its opinion that the constitution of the society does not contemplate the admission of women. On Jan. 6, 1915, Mrs. Blatch again applied for transfer to the associate-membership grade, and she claims that a majority of the board voted in her favor. According to the society's constitution, election to membership is by letter ballot of the Board of Direction; and in such letter ballot at least 25 votes must be cast, and 3 or more

negative votes exclude from election. Mrs. Blatch's attorney based his chief argument on the claim that according to the constitution the above restriction applied only to election to membership and not to transfers from one grade to another, and that under the general corporation law a majority of votes in favor of the transfer was all that was required. The brief of the society's attorney, W. C. Runyon, declared that Mrs. Blatch's application for associate membership had been acted on in accordance with the society's constitution; and the judgment of a court should not be substituted for the judgment of the society's Board of Direction. The judge decided against the plaintiff, saying: "I know of no authority in this court to direct a private corporation to elect or admit any member."

PERSONALS

Mr. F. R. Perkins has been elected Engineer in Charge of Construction, Dallas (Tex.) Southwestern Traction Co.

Mr. B. S. Wathen, M. Am. Soc. C. E., Consulting Engineer, Dallas, Tex., has been elected Consulting Engineer of the Dallas Southwestern Traction Co.

Mr. R. D. Goodrich, City Engineer of Cheyenne, Wyo., has been appointed Manager of Municipal Public Utilities, under the Board of Public Works, of Ypsilanti, Mich.

Mr. S. E. Elmore, formerly Central Sales Manager of the Bucyrus Co., of South Milwaukee, Wis., has been made Superintendent of the Evansville plant of the company.

Mr. John T. Witt has been elected Chief Engineer of the Dallas (Tex.) Southwestern Traction Co. The company proposes to construct an interurban line from Dallas to Clebourne and Glen Rose.

Mr. George Hogarth, Assoc. M. Can. Soc. C. E., formerly Assistant Engineer of the Department of Public Works of Ontario, has been appointed Chief Engineer of the Department of Highways of the Province of Ontario.

Mr. Oscar E. Thomson, Consulting Mechanical Engineer, of Phoenixville, Penn., has been appointed Mechanical Engineer in the Hygiene and Engineering Division of the Pennsylvania Department of Labor and Industry. He succeeds Richard M. Pennock, Safety Engineer for the state insurance board.

Mr. DeWitt V. Moore recently resigned from the position of District Engineer of the Central District of the Division of Valuation of the Interstate Commerce Commission, with headquarters at Chicago, to specialize in valuation work in a consulting capacity. His offices are in the Lytton Building, Chicago, Ill.

Mr. William B. Bennett, M. Am. Soc. C. E., Consulting Engineer, has been appointed City Engineer of Niagara Falls, N. Y. Mr. Bennett was formerly connected with the Hydraulic Power Co., of that city. He will continue his practice as consulting hydraulic engineer in addition to the duties of his new appointment.

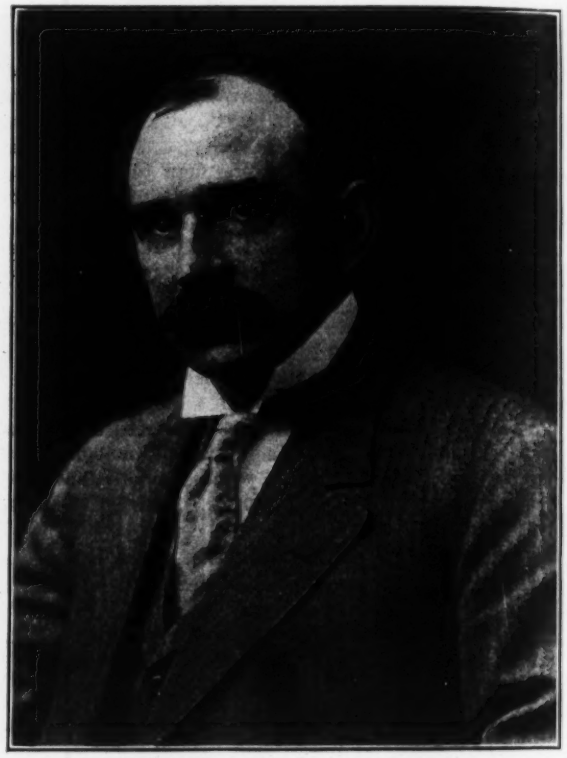
Mr. C. G. Elliott, M. Am. Soc. C. E., has become affiliated with the Harman Engineering Co., of Peoria, Ill., which corporation will hereafter be known as the Elliott & Harman Engineering Co. Mr. Elliott will be in charge of the Eastern branch office of the company, at 503 McLachlen Building, Washington, D. C., and will continue his practice as consulting drainage engineer.

Mr. Lucius T. Berthe, Assoc. M. Am. Soc. C. E., of Charleston, Mo., County Surveyor of Mississippi County, has been selected as engineer in charge of the proposed work of the new drainage district in the Dog Tooth Bend section above Cairo, Ill. Mr. Berthe has just completed improvements in Mississippi County representing an outlay of $1,500,000. The Dog Tooth Bend improvements are to protect over 20,000 acres of land from high waters and will also reclaim an extensive area of swamp land.

Messrs. Robert Spurr Weston, M. Am. Soc. C. E., Consulting Sanitary Engineer, and George Arthur Sampson, Assoc. M. Am. Soc. C. E., Principal Assistant Engineer to Mr. Weston, have formed a partnership under the name of Weston & Sampson for the practice of engineering. They will continue to occupy the offices at 14 Beacon St., Boston, Mass., where they have been for many years. Mr. William Wheeler, M. Am. Soc. C. E., will coöperate with the new firm, mainly in an advisory capacity. They will specialize in water-supply and purification, sewerage and sewage disposal and the disposal of municipal and factory wastes.

Mr. A. N. Johnson, M. Am. Soc. C. E., recently connected with the Bureau of Municipal Research of New York City, has been apointed Consulting Highway Engineer of the Association of American Portland Cement Manufacturers with headquarters in the new offices of the association at 111 West Washington St., Chicago, Ill. Mr. Johnson is a graduate of Harvard University. He was at one time Third Assistant Engineer of the Massachusetts Highway Department and was State Highway Engineer of Maryland for seven years. He served in a similar capacity for eight years in Illinois and was for a year Chief Engineer of the United States Office of Public Roads.

Albert H. Scherzer, president of the Scherzer Rolling-Lift Bridge Co., of Chicago, and widely known in the engineering world in connection with the introduction of the bascule type of drawbridge, was killed, Jan. 28, by falling down an elevator shaft in the Monadnock Building, Chicago. The company has its offices on the sixteenth floor and keeps a number of its books and papers on the seventeenth floor, which is used only for storage and service purposes. A passage to the storeroom opens to the elevators, and here the part of the



ALBERT H. SCHERZER

shaft where Mr. Scherzer fell was closed only by a low hand rail. The place is dimly lighted. A few minutes previously Mr. Scherzer had obtained the key to the storeroom. As he was apt to be absent-minded or preoccupied, the assumption is that he in some way stumbled and fell over the rail. Mr. Scherzer was widely known in the engineering world for his development of the bascule type of drawbridge. He organized the present company in 1897 to introduce the rolling-lift bascule bridge, which had been invented in 1893 by his brother, William Scherzer, a consulting engineer of Chicago. When the Metropolitan Elevated R.R. wanted to build its bridge across the Chicago River it was found impracticable to use a swing bridge, as it was between the two existing swing-bridges at Van Buren St. and Jackson St. William Scherzer was consulted and designed the rolling-lift bridge, which was adopted; but he died before the completion of the bridge in 1895. Albert H. Scherzer realized the possibilities of this new type of bridge and patented it. In 1896 designs were made under his direction for different structures, including the Vernon Ave. bridge over the Harlem River at New York. He made a close study of bridge design, and when the company was organized he was prominent in its technical as well as in its commercial department. In fact, a number of the improvements and developments were due to his ideas and suggestions. There are now about 230 bridges of the Scherzer type in service or under construction, many of these being

notable structures and several of them being in foreign countries. Mr. Scherzer was particularly proud of the extensive and widespread use of his bridges. Of late years he had become specially interested in the matter of waterways and inland navigation and had given less attention to the bridge and to the affairs of the company. Albert H. Scherzer was born in Peru, Ill., in 1865. After going through the high school he went to Switzerland and graduated from the Technical School at Zurich. In 1892 he graduated from the Union College of Law at Chicago, and then practiced law until his interest was attracted to the possibilities of the development of the bascule bridge. In 1902 he married Donna G. Adair, of Madisonville, Ohio, who survives him. They had no children.

OBITUARY

John Humphrey McCarthy, a railroad builder of national reputation, died at 76 years of age at Little Rock, Ark., on Feb. 10. Colonel McCarthy constructed the Missouri, Kansas & Texas; Atchison, Topeka & Santa Fé; Missouri Pacific and other roads.

John H. Gerrish, President of the Gerrish Dredging Co. and formerly Treasurer of the Eastern Dredging Co., of Boston, died at his home in Melrose Highlands, Mass., on Feb. 7, at 57 years of age. In his connection with the dredging companies mentioned Mr. Gerrish was engaged on a number of the larger engineering works about Boston, including the Charles River dam, one of the Commonwealth piers at South Boston and the Charles River embankment.

Walter Frank Carr, M. Am. Soc. C. E., Consulting Engineer and Manufacturers' Agent, of Seattle, Wash., died at his home in that city on Feb. 3, at 55 years of age. Mr. Carr formerly was Superintendent of the Track Department of the Chicago street railways and as Chief Engineer had charge of the construction of the Twin City electric system between St. Paul and Minneapolis. For 13 years he was also Chief Engineer of the Falk Co., of Milwaukee, Wis. He was a graduate of the Massachusetts Institute of Technology, class of 1884.

Stevenson Towle, M. Am. Soc. C. E., for 18 years Chief Engineer of the Department of Sewers of New York City, died at Mamaroneck, N. Y., on Feb. 14, in his seventy-ninth year. At various times he was also Park Commissioner, a member of the first Rapid Transit Commission, a member of the commission that laid out Long Island City and Consulting Engineer of the Department of Health, Department of Pavements and the Consolidated Gas Co. He was born at Prince Bay, Staten Island, N. Y., and was a graduate of the College of the City of New York.

William Jasper Nicolls, M. Am. Soc. C. E., engineer and writer, died suddenly at Philadelphia on Feb. 14, at 63 years of age. He was born at Camden, N. J., and received his education in the Hill School at Pottstown, Penn. In 1873 he was appointed Assistant Engineer of the Reading Ry. and two years later became Chief Engineer of the Pennsylvania Steel Co. He was appointed in 1880 Chief Engineer of the Long Island R.R., which position he held for two years, and then engaged in the private practice of mining and civil engineering. He studied and wrote extensively on the subjects of coal mining and railroad construction.

ENGINEERING SOCIETIES

COMING MEETINGS

NINTH CHICAGO CEMENT SHOW.
Feb. 12-19. First Infantry Armory and Coliseum. Secy., R. F. Hall, 208 South La Salle St., Chicago, Ill.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 14-15. Annual meeting at New Haven. Secy., J. Frederick Jackson, Chamber of Commerce Bldg., New Haven, Conn.

BUILDING INSPECTORS' CONFERENCE.
Feb. 14-15. In Chicago. Secy., S. J. Williams, Madison, Wis.

AMERICAN CONCRETE INSTITUTE.
Feb. 14-17. Annual convention in Chicago. Secy., John M. Goodell, 1418 Walnut St., Philadelphia, Penn.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 14-17. Annual meeting in New York City. Secy., Bradley Stoughton, 29 W. 39th St., New York City.

ASSOCIATION OF ONTARIO LAND SURVEYORS.
Feb. 15. Annual meeting in Toronto, Can. Secy., L. V. Rorke, Parliament Building, Toronto, Ont.

SECOND NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.
Feb. 15-18. At Chicago. Secy., J. P. Beck, 208 South La Salle St., Chicago, Ill.

IOWA ENGINEERING SOCIETY.
Feb. 16-18. Annual meeting at Des Moines. Secy., J. H. Dunlap, Iowa City, Iowa.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
Feb. 16. Annual meeting in Boston. Secy., N. W. Gifford, 38 Central Sq., East Boston, Mass.

AMERICAN CONCRETE PIPE ASSOCIATION.
Feb. 17-18. Annual convention in Chicago. Secy., E. S. Hanson, 538 South Clark St., Chicago, Ill.

IDAHO SOCIETY OF ENGINEERS.
Feb. 21-23. Annual meeting in Burley. Secy., I. F. Shaffner, Boise, Idaho.

ARKANSAS ENGINEERING SOCIETY.
Feb. 22-23. Annual meeting at Helena. Secy., W. J. Parkes, Citizens Bank Building, Pine Bluff, Ark.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 28 to Mar. 3. Annual convention in Pittsburgh. Secy., E. L. Powers, 150 Nasau St., New York City.

ENGINEERING SOCIETY OF WISCONSIN.
Feb. 25-26. Annual meeting in Madison. Secy., L. S. Smith, Madison, Wis.

Iowa State Drainage Association will hold its annual meeting in Fort Dodge, Feb. 24 and 25. The secretary is M. F. P. Costelloe, Ames, Iowa.

Association of American Portland Cement Manufacturers has removed its headquarters from Philadelphia to Chicago, where offices have been established at 111 West Washington St.

American Institute of Consulting Engineers elected on Feb. 2 the following officers for 1916: President, Dr. Elmer L. Corthell; vice-president, George Gibbs; secretary and treasurer, F. A. Molitor.

Western Society of Engineers has elected as secretary E. N. Layfield, M. Am. Soc. C. E. He was made assistant secretary about a year ago and has been acting secretary since the death of J. H. Warder.

Canadian and International Good Roads Congress—The third Canadian Road Congress will be at Montreal, Can., Mar. 6 to 10. It is expected that delegates will attend from all the provinces of Canada and from the United States.

Connecticut Society of Civil Engineers held its thirty-second annual meeting in New Haven, Feb. 15 and 16. At the business session ten papers were presented, dealing with water-supply, sewage-disposal, Federal valuation of railways, telephony, river and harbor improvements, electric street-railway maintenance and bridge construction. The secretary is J. Frederick Jackson, New Haven.

Idaho Society of Engineers holds its seventh annual convention in Burley, Feb. 21 to 23, with headquarters at the National Hotel. A luncheon will be held on Monday, immediately following which President Dibble, Colonel Miller, mayor of Burley, and F. A. Wilkie, state engineer, will speak. Some of the papers to be read are "The Camera and the Engineer," "Phosphate Deposits in Southern Idaho," "Irrigation Pumping and Power Rate Therefor," "Hydrometric Data and Practice on the Minidoka Project," "Silting of Canals and the Minidoka Drainage System" and "Surveys of Overflowed Lands in Arkansas." The annual banquet will be held in the evening at the National Hotel. The next morning there will be an inspection trip to the Minidoka project. The chairman of the entertainment committee is J. S. Longwell.

New England Water-Works Association held a meeting at the Hotel Brunswick, Boston, on Feb. 9. Following the usual luncheon, a business meeting was held, at which it was voted not to collect an initiation fee from members of the American Water-Works Association who join the New England Water-Works Association during 1916. This action was like that taken last year, which resulted in a large increase in the membership of the association. It was also voted that a committee of the association be appointed to confer with the National Board of Fire Underwriters on grading the insurance rate. The causes of explosions of domestic boilers were discussed at considerable length, and tests were made on a number of different makes of release valves, in order to demonstrate their operation. The paper on the "Progress of Water Sterilization in Maryland," by Robert B. Morse, Chief Engineer, and H. L. Hall, Assistant Chief Engineer, Department of Health, Baltimore, Md., was read by C. M. Saville in the absence of the authors. A committee on meter rates, which presented a progress report in 1914, made a final report at this meeting. After some discussion it was voted that the report be printed and sent to members, in order that the subject might be more fully discussed at a later meeting.

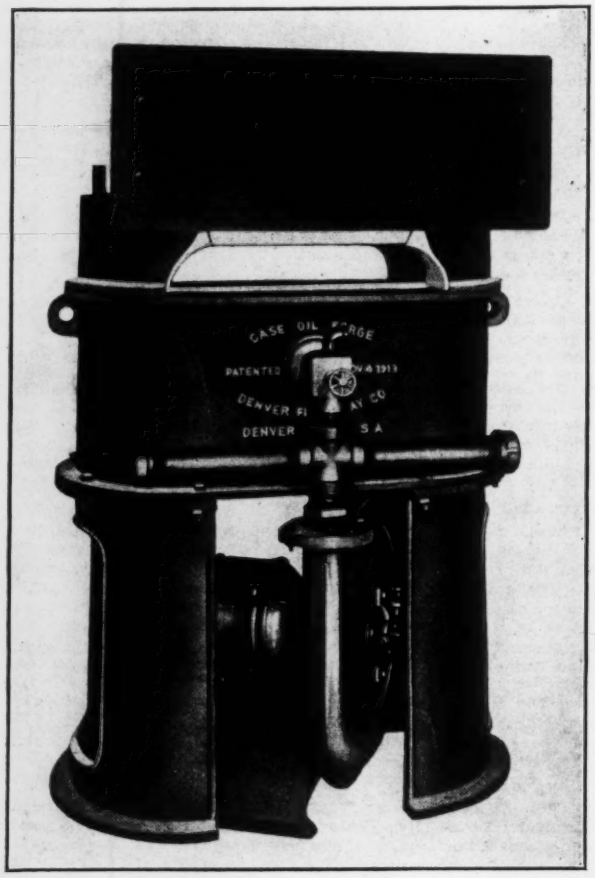
New Jersey Sewage-Works Association—Acting on a suggestion from Clyde Potts, a member of the New Jersey State Department of Health, 16 men from as many towns met at Trenton on Jan. 28 and organized the New Jersey Sewage-Works Association. John R. Downes, of Plainfield, N. J., was elected president, and Fred T. Parker, of the Atlantic City Sewerage Co., was elected secretary and treasurer. Besides an annual meeting there will be two meetings a ar at different sewage-disposal works in the state.

Appliances and Materials

Low-Pressure Oil-Burning Forge

A forge in which drill steels can be heated, which can be used for miscellaneous small blacksmithing, which burns fuel oil and is supplied with low-pressure air from an electric-driven blower underneath is being manufactured by the Denver Fire Clay Co., of Denver, Colo.

The opening to the forge is designed to hold drills or puncher bits and has a heating capacity, when operated steadily, of nine 1¼-in. steels per min. The forge is almost noiseless, because the air used is at a pressure of only about 6 oz. The fan is operated by a 1½-hp. motor. The manufacturer states that in a shop in which machine sharpeners are employed, it will be found that this 20-in. forge, equipped with a Case burner, can keep two sharpeners supplied with heated steels.



NEW CASE OIL FORGE FOR DRILL STEELS

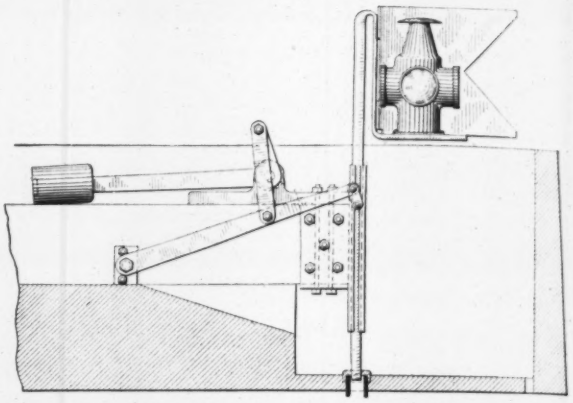
* * *

Acid-Resisting Alloy

A new formula for an acid-resisting alloy has been worked out by Prof. S. W. Parr, of the University of Illinois, Urbana. The composition is reported to be: Copper, 6.42%; manganese, 0.98%; silicon, 1.04% tungsten, 2.13%; nickel, 60.65%; aluminum, 1.09%; iron, 0.76%; chromium, 21.07%; molybdenum, 4.67%; boron and carbon not determined. The properties are reported to be due to "careful proportioning of electro-positive and electro-negative metals."

Disappearing Switch Light

A new switch-lamp stand for sidings from main-line tracks is being made by E. F. Hartzell, of East Bakersfield, Calif. As shown in the accompanying sketch, a concrete or masonry pit for the lamp to drop into is made at the switch stand. The lamp and target are mounted on a rod which moves vertically in a guide on the switch-stand tie. The lamp is set to rise out of the pit when the switch is thrown for the siding. A steel pit cover may be added to the target to keep out rain. It is reported that this type has been used with satisfaction by the Southern Pacific Co., at Bakersfield, Calif.

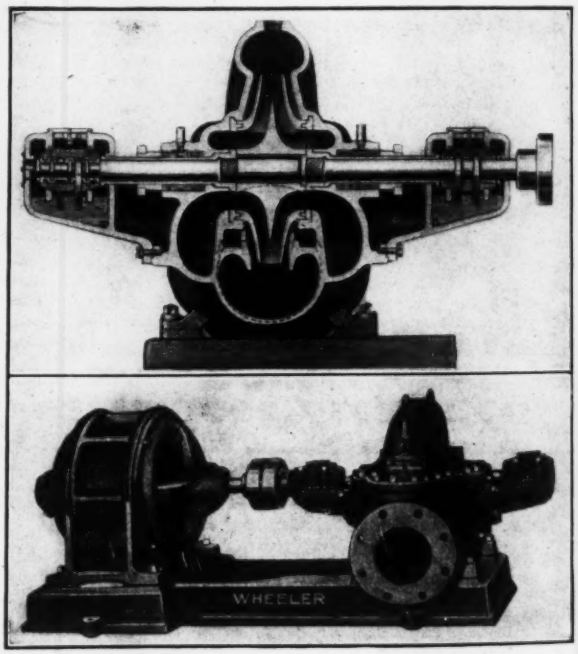


HARTZELL DISAPPEARING SWITCH LIGHT

* * *

Small Centrifugal Pump for Tank Service

A small motor-driven centrifugal pump is now being built by the Wheeler Condenser and Engineering Co., of Carteret, N. J. The figure shows the general features of the pump. It has a two-part divided casing, with both suction and discharge nozzles in the lower half. The impeller is of the closed double-suction type, protected by labyrinth wearing rings. The shaft is protected from the water by bronze sleeves that screw on the shaft and extend through into the bearing-bracket boxes. Bearings are of the ring-oiled type. There is a ring-oiled thrust bearing which the manufacturer claims is not commonly found in double-suction single-stage pumps. The pump shown is intended for tank or standpipe service.



SMALL MOTOR-DRIVEN PUMP FOR STANDPIPE SERVICE

Engineering News

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Contents, First Page
Advertising Index, Last Page

PERIODICAL ROOM
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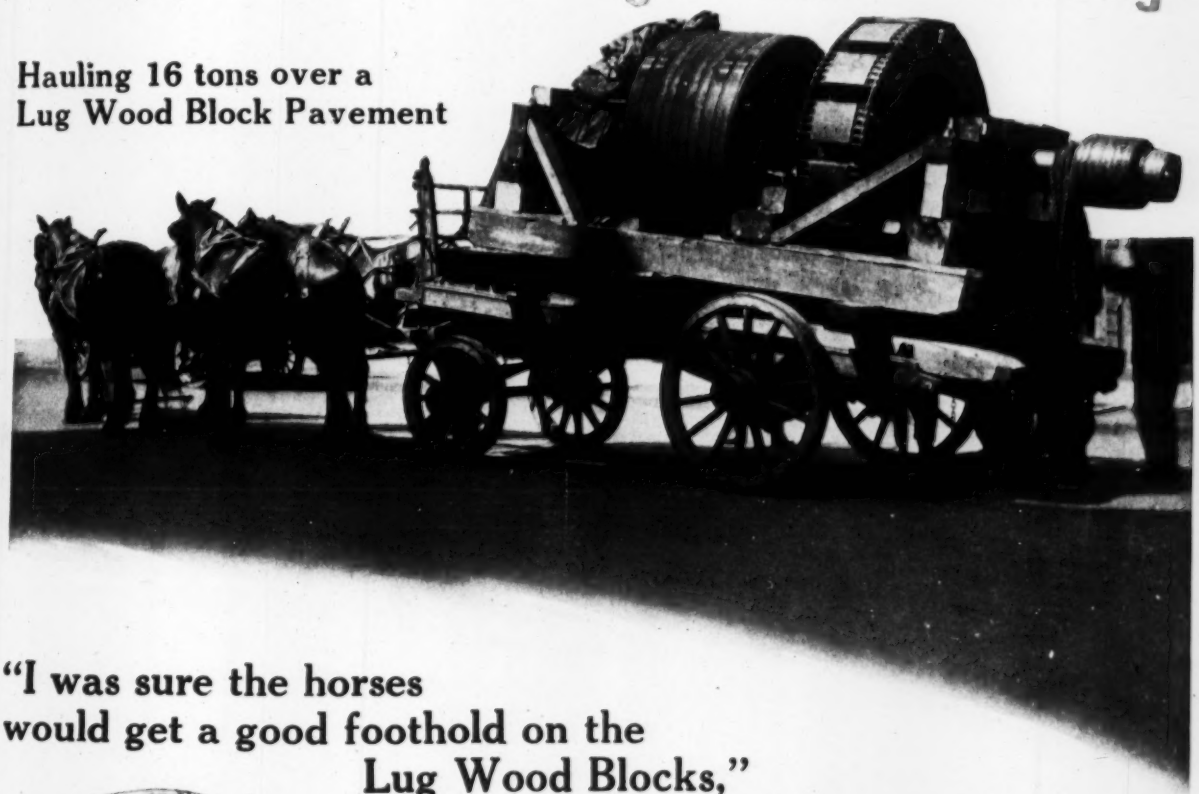
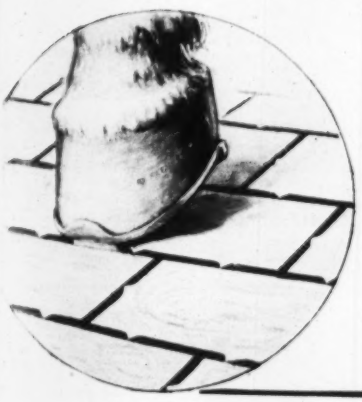
Kreolite Lug Wood Blocks

"The Paving that's Saving"

Hauling 16 tons over a Lug Wood Block Pavement



"I was sure the horses would get a good foothold on the Lug Wood Blocks,"



said the teamster of the McGettigan Cartage & Storage Co. of Toledo, Ohio, when asked why he drove his truck and its 16-ton load over the Kreolite Lug Wood Block Pavements on Jefferson Avenue, Toledo, Ohio.

The expansion spaces provided by the side lugs on Kreolite Blocks give a good foothold for horses. The calks on their shoes grip the edges of the blocks, absolutely eliminating all slipperiness of the pavement.

The lugs forestall "bleeding"—the creosote stays in the wood.

The trucking companies and teamsters appreciating these advantages are the strongest boosters of Lug Wood Block Pavements.

The lugs on each block provide individual expansion joints. When the blocks expand the lugs compress, preventing any bulging or bleeding of the pavement.

The result is a pavement which retains its firm, compact surface, does not bulge or bleed and is not slippery—a noiseless pavement—a pavement that gives the maximum in wear and the minimum in maintenance costs.

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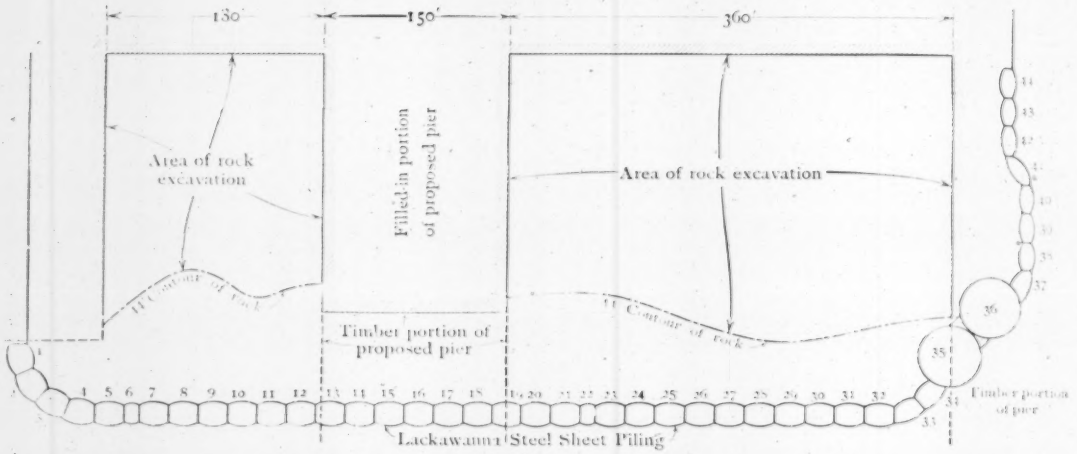
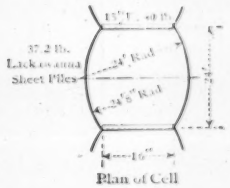


The Novel Type of Steel Sheet Piling Pocket Utilized in Building the 46th St. Cofferdam, N. Y.

The most nearly comparable precedents for the 46th Street Cofferdam were the circular pocket cofferdam constructed for raising the U. S. Battleship Maine from Havana Harbor and the square pocket cofferdam for the construction of the Black Rock Ship Lock, Buffalo, N. Y. Both of these cofferdams (described in detail in our Bulletins Nos. 102 and 103, which will be sent on application) were constructed exclusively from Lackawanna Steel Sheet Piling, were of the filled pocket type and were designed to be independently stable.



Plan of Cell

The type of pocket used at 46th Street was designed to combine the best features of both circular and square pockets as demonstrated in the Maine and Black Rock works.

Each consisted of two slightly rounded outer walls with joining transverse straight walls 24 feet apart, as shown in the smaller sketch. The convex inner and outer faces varied from 16 feet apart at the transverse walls to 22 feet apart at the centers. The transverse walls were each braced by a heavy channel crossing the wall and bolted to each separate sheet pile, the additional bracing being placed for added stability during construction of the pockets. The connection of one cell to another is made with our special three-way sheet pile known as No. 9. It is evident that this type of pocket has a much greater minimum thickness than a circular pocket and is less subject to distortion than is either a circular or a square pocket.

Two of the cells, numbers 35 and 36, had to be made circular in plan and of much larger size (55 feet diameter) than the standard, owing to the necessity of clearing the corner of an existing pier at the foot of 44th Street.

The two cells, numbers 6 and 22, which were left open up to the time of unwatering, for the passage of barges loaded with construction material, were made narrower than the standard cells, but of the same general type.

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General Sales Office and Works: Lackawanna, N. Y.

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Engineering News

VOLUME 75 FEBRUARY 24, 1916 NUMBER 8

Brazilian Opportunities and the Brazil Railway

By F. E. Lawrence*

SYNOPSIS—Facts about the geography and climate of Brazil, bearing on engineering work. Lines and organization of the Brazil Railway Co. Features of location, construction, maintenance, equipment and operation. Labor conditions. Inducements offered settlers. American engineers warned not to rush into the country without knowledge of language and people—unless employed by a moneyed corporation.

South America is about as well known to the people of the United States as is central Africa, but our manufacturers are waking up to the surprisingly good opportunities there for trade.

Brazil is greater in area than the United States, excluding Alaska, and is very much larger than Argentina. With double the population of Argentina it has one-half the mileage of railroads; only a fringe along the coast of Brazil is settled. The vast inland country, with its rich soil, great water courses and potential water powers, its trackless forests of hardwoods and pine, remains untouched by civilization. This section of Brazil will experience a wonderful growth in the next decade.

The popular impression of Brazil is that of a hot unhealthful tropical country devoted entirely to coffee and rubber plantations. This conception is far from the truth, for only in the extreme north, in the basin of the great Amazon River, is rubber obtained; and practically all the coffee produced in Brazil, which is, by the way, about 70% of the world's production, comes from the one state of Sao Paulo.

North of the twentieth degree of south latitude, which crosses Brazil consideraly to the north of Rio de Janeiro, the climate is tropical. South of that line the climate is delightful, with the exception of the narrow low coastal strip that lies between the sea and the range of mountains that parallels the east coast. In summer this strip is tropical, but in winter it corresponds to Florida.

The Brazil Ry. traverses the four southernmost states of Brazil. Starting at Sao Paulo, the capital of that state, it extends southward to the borders of Uruguay. It comprises practically all the railway lines south of the

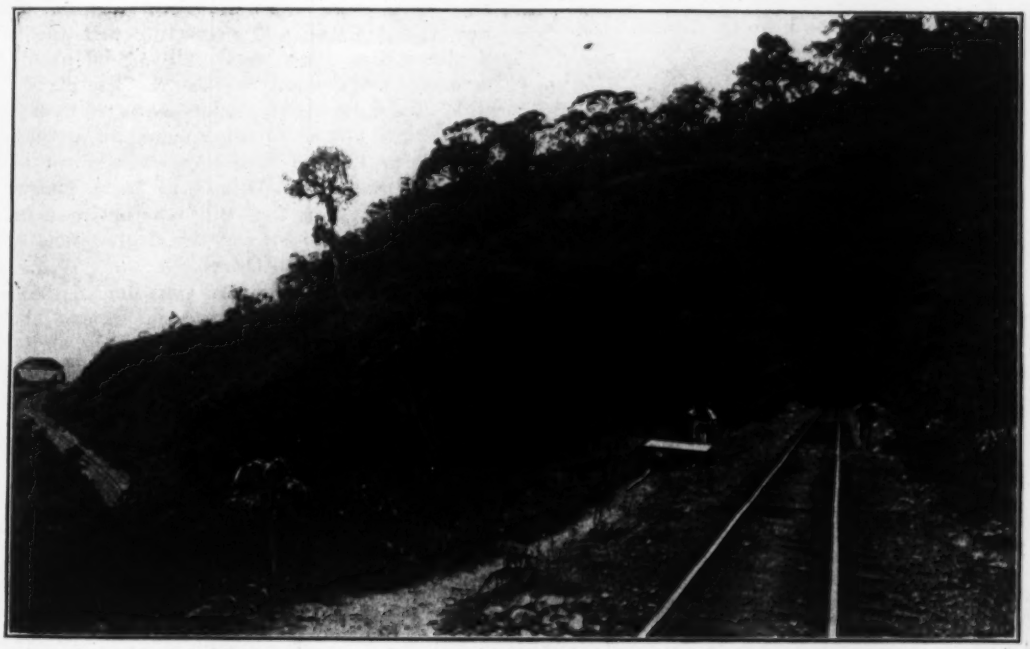


FIG. 1. TYPICAL PIECE OF DEVELOPMENT AND STEEP GRADE ON THE MOUNTAIN DIVISION OF THE PARANA RY., BRAZIL

*415 West 36th St., Savannah, Ga.

City of Sao Paulo and provides an all-rail route between Rio de Janeiro and Montevideo, the capital of Uruguay, and to Buenos Aires in Argentina.

The Brazil Railway Co. is in effect a holding company, incorporated under the laws of Maine. The physical creation consisted of connecting various existing properties. The organizer and head of the syndicate is a well-known American railroad financier, Percival Farquhar, but the capital employed is largely French, Belgian and English. The central offices, previous to the European War, were in Paris, with branch offices in London and New York. The operation of the properties in Brazil has been, for the most part, in American hands. The war has forced the system to rely, rather prematurely, upon its own efforts at earnings; and despite the exceedingly hard times in Brazil, it is making slow but satisfactory headway. The general direction of the Brazilian Ry. is parallel to the coast, but with one exception (projected) the lines do not operate for coastwise traffic, it being impossible to meet the competition of sea routes.

All the lines are of meter gage—the prevailing standard in Brazil—although some of the English lines and the Government-owned Brazil Central Ry. are broad gage. The adoption of the meter gage was due largely to French influence; French capital initiated railways in southern Brazil, and Brazilian engineers adhere principally to French practice.

Lines Under Construction and Proposed

The various roads that make up the Brazil Ry. system are as follows:

Road	Km. In Operation	Km. Under Construction	Total
Sorocabana Ry.	1,319	...	1,310
Sao Paulo Rio Grande Ry.	1,439	200	1,639
Parana Ry.	417	...	417
North Parana Ry.	45	...	45
Auxiliaire Ry.	2,159	12	2,171
Thereza Christina Ry.	116	...	116
Sao Paulo Southern Ry.	...	140	140
Total	5,486	352	5,838

This is equivalent to 3,628 mi. of track.

Only two of the projected extensions of the Brazil Ry. are now under construction, one being the Orinhas line

FIG. 2. LINE OF PARANA RY. ASCENDING THE PARANA SERRA

FIG. 3. PLATE GIRDER VIADUCTS; MOUNTAIN DIVISION, PARANA RY.

from Jaguariahyva to Orinhas, the other being the Sao Paulo Southern, mentioned. The following lines have also been projected:

1. The Guarapuava Line—A branch of the Sao Paulo Rio Grande Ry. from Ponta Grossa going westerly to Guarapuava, in the state of Parana. As it will penetrate a new and rich part of the state, it will probably be the next line to be built. It will ultimately be extended farther west to develop the almost unknown interior.

2. The Short Line, Curityba to Sao Paulo—A line running northeast from Curityba, gradually descending the mountain wall and connecting with the Sao Paulo Southern Ry. This route will cut off about 300 km. between Curityba and Sao Paulo. The maximum gradients will be greatly reduced as compared with the present line or with any of the other mountain divisions.

3. Porto Tibirica Line—An extension of the Sorocabana Ry. from Salto Grande to Porto Tibirica, on the Rio Parana. This line will tap the great Rio Parana and initiate an invasion of the virgin wilderness beyond in the state of Matto Grosso.

4. Rio Iguassu Line—An extension of the Sao Paulo Rio Grande west from Porto da Uniao, following the Iguassu River to its mouth at the Falls of the Iguassu, and a branch from this latter point to the Sete Quedas Falls on the Parana River.

Both of these waterwalls are greater in volume of water and height of fall than Niagara. What a region of industry and activity some day this will be! It awaits the colonist and capitalist.

5. Sao Paulo-Montevideo Coast Line—A coast line from Sao Francisco to Porto Alegre, one part of a coast-line route, for which preliminary surveys have been made, from Santos to Montevideo in Uruguay. While this route, 2,700 km. long, will eventually be completed, it is a dream of the future, for the country could not at present furnish enough local traffic to make the line pay, and it could not compete for through service with steamers between those ports.

6. Sao Paulo-Santos Line—At present there is only one line between Sao Paulo and Santos, the Sao Paulo Ry., owned and operated by an English company. Over the mountain it maintains an 8% grade, operated by cables. It handles nearly the entire coffee output of Brazil and is one of the richest short railroads in the world. Capitalized at $200,000 per mi., its annual operating income is close to $100,000 per mi.

Studies have been made by S. F. Shaw, former chief engineer of the Brazil Ry., for another line with a grade of 2.5%, which would entail very heavy work, and also for an alternate line with steeper grades. Present conditions have relegated the idea to the background.

The two most interesting "serras," or mountain divisions, are those of the Parana and Sao Francisco Lines. The former was constructed about 30 years ago by the French, and the latter was completed only last year by the Brazil Ry.

All the serras are now operated with Mallet locomotives, most of which weigh, without tender, 78 tons and have a tractive effort of 29,500 lb. Somewhat heavier locomotives are used on the Sorocabana Ry. They give satisfactory results and work well on the sharp curves.

The maximum gradient of the Sao Francisco serra, uncompensated for curvature, is 3%, and the minimum radius of curvature is 100 m. As the line back of this

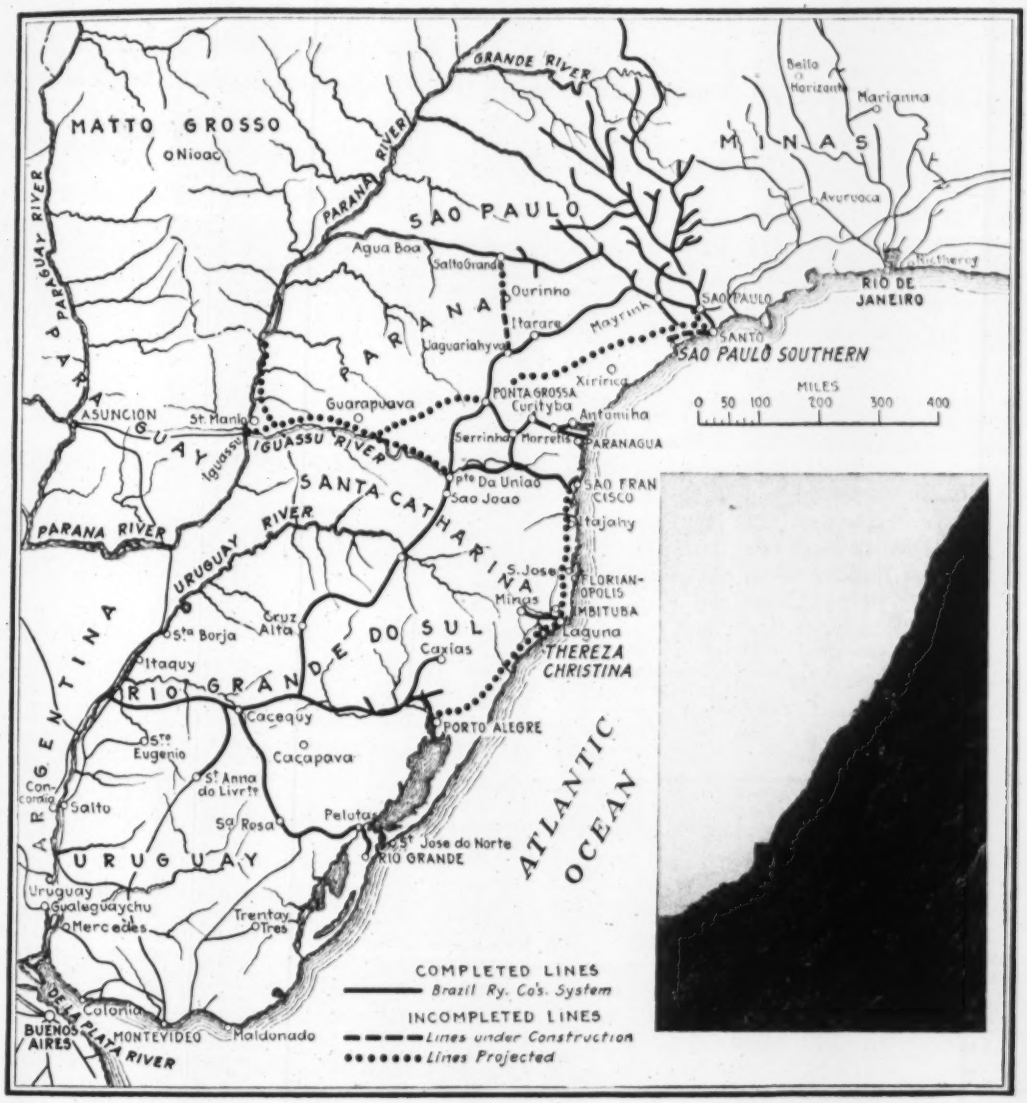


FIG. 4. MAP OF BRAZIL RAILWAY CO'S SYSTEM; VIEW OF VIADUCT ON PARANA SERRA

The engineering features of these two serras are much alike, the track in both places zigzagging up the steep mountain sides, taking advantage of every natural topographical help to gain elevation. The height reached by the Parana serra is 3,123 ft., and this in a distance of 38 km. The maximum grade, compensated for curvature, is nearly 4%, and the minimum radius of curvature is 78 m., which is equivalent to a curvature of approximately 22° 30′ per 100-ft. station. There are in the 38 km. of climb 14 tunnels and a great number of viaducts and bridges.

serra has no adverse grades in either direction greater than 0.5%, it provides a low-grade line for all products going out of the country.

Construction and Maintenance

The national Government, through its "fiscal engineers," exercises an authority over the railroads something similar to our Interstate Commerce Commission. All methods and changes of construction and operation must be passed on and approved by the fiscal engineers before they can be put in force. In the construction of bridges, building, culverts and track only the most enduring and permanent types are permissible. Timber

bridges, trestles and culverts are never used, except for temporary use as falsework or until the permanent structure can be erected. The majority of stations are also of masonry. Bridges are constructed of steel and masonry or concrete, and nearly all culverts are of masonry. In Brazil, where cement must be imported, granite masonry with cement or lime-mortar joints is considerably cheaper than concrete, and this type of construction is consequently much more common than concrete.

No attention was paid until recently to the alignment and grades of railways, and as a consequence the older lines of the system are simply a succession of sharp grades with excessive curvature. On many lines no attempt was made to follow the natural water grade. The natural topography of southern Brazil is very broken. Behind the coastal range there are no continuous ridges, but the hills rise up like a field full of immense ant-hills. Ridge routes are therefore, as a rule, out of the question.

Brazil has suffered, as did the United States, from irresponsible railway promoters, whose only object was to get as many kilometers of line, of as light a character as possible, between two points; who made their profit on the construction, with not a thought of the future operation of the line. Many roads are now struggling with the effects of that criminal policy. Of late years there has come a change, and the locations of recently constructed lines compare favorably with the best of those in Europe and North America. The Sao Francisco Line, for example, was partly located by American engineers and constructed by French. With the exception of the mountain division between Hansa and Sao Bento the maximum grade both ways is 0.5%, and the minimum radius of curvature is 150 m., or 70° 40′ metric, and this minimum is seldom used.

Surveys have been made to reconstruct almost the entire Parana Ry. and much of the Sao Paulo Rio Grande

FIG. 5. GREAT CATARACT OF THE RIO IGUASSU

The volume and height of fall exceed that at Niagara. On the western boundary of Parana, hundreds of miles from a railway

and Auxiliaire Railways. The Sorocabana, as a whole, is much better built as respects alignment and grades than any of the other lines.

The T-rail, as used in the United States, but of European design, has been in use on all the lines from their inception, the weights used averaging from 40 to 60 lb. per yd. In 1912 a great many thousands of tons of new rail—75 lb. per yd., Am. Soc. C. E. section—was ordered in France and Belgium to relay most of the Sorocabana, Parana and Auxiliaire Railways. A considerable amount of this rail has been laid, but many hundred kilometers yet remain to be put down.

Practically all sleepers are of hardwood, in which it is first necessary to bore holes before spikes can be driven. On most of the new lines screw spikes are used. The timber used for sleepers (principally "Imbuia," of a dark,

FIG. 6. TERMINAL OF THE PARANA RY. AT PARANAGUA

Locomotive fuel briquets piled ready for loading

greenish color, which makes beautiful furniture) lasts on an average from 16 to 20 yr.; and if free from faults when placed in the track, it will last for 35 yr.

Tie-plates or rail-braces are rarely used, for even on the mountain grades, with their very sharp curves and heavy locomotives, no trouble is incurred with canting rails, as the timber is hard enough to resist the cutting action, and spikes once driven do not come out.

The usage with respect to ballast, both rock and earth, is to cover the track completely, flush with the bottom of the head of the rail. It is claimed that the timber in the track lasts longer and that the track on the sharp curves is held in place better by this method. On the other hand, it is very difficult to inspect the condition of the sleepers and rail connections. This mode of ballasting certainly reduces the noise in passenger travel, the principal noise noticed being the gritty grinding around curves.

On the older parts of the roads the European practice of placing the joints opposite each other is used, which causes an annoying series of jolts on track that is not kept in perfect condition. The joints on all recently built lines are staggered, and wherever new rail is laid.

Rolling Stock and Fuel

Since the beginning of operation the majority of the locomotives used have been of American make, supplied almost exclusively by the Baldwin Locomotive Works. The Auxiliaire Ry. had besides a number of German locomotives.

After the different roads had been incorporated into the Brazil Ry., Mallet locomotives—type 2-6-6-2, tractive effort 29,500 lb.—were purchased for all the mountain divisions; and a number of type 0-6-4, tractive effort 19,000 lb., were secured for passenger and freight service in the plateau country. Practically all these locomotives, although designed by American mechanical engineers and according to American standards, were purchased from the Henchel Locomotive Works, of Cassel, Germany.

Subsequent orders were placed with the American Locomotive Co. for a number of similar locomotives, but equipped with superheaters and other modern appliances. These latter Mallets have shown to great advantage as

compared with the first, for they handle from 10 to 20% more load and use about 20% less fuel.

The rolling stock, box- and flat-cars, etc., used on the various lines were all of European pattern and build and were, for the most part, 4-wheel, 4-, 6-, and 12-ton wagons with link couplings. The passenger coaches also were of antique 4- to 8-wheel design and weighed about 9 tons. Since the Brazil Railway Co. assumed control, box-, cattle- and flat-cars of 30 and 40 tons' capacity, and very comfortable modern passenger coaches, wicker seated and electric lighted, were purchased in Belgium, having also been designed according to the latest American specifications. Automatic couplers and vacuum brakes were introduced on all new rolling stock, both passenger and freight.

The Sorocabana and Auxiliaire Railways use coal exclusively for fuel, and the Parana and Sao Paulo Rio Grande Railways use coal for passenger and wood for freight trains, although on the mountain divisions some coal is used in conjuction with wood by freight trains.

The coal is, or was previous to the war, purchased in the British Isles and comes in briquettes. It is shipped to the various ports, unloaded by hand from the hold of the vessel, stored or loaded again for transportation over the line to intermediate points, stored at these points and finally loaded on the tender of the engine. All this transferring is done by hand, the method of loading or unloading being a human chain passing the briquettes one by one. Each briquette must pass through from 30 to 50 men's hands from the time that it is unloaded at the dock to the time it enters the locomotive firebox. When the coal is piled for storage, it is arranged in geometrical pyramids, carefully built up.

The cost of coal on the tender averages about $16 per ton, which makes the fuel item of operating expenses very high. On the Parana Ry. the fuel item for 1913, during which time coal was used exclusively, amounted to 31% of the total operating expenses.

The use of wood for fuel on those parts of the system where wood abounds brings the charge down somewhat, but at the usual price for wood not much saving is obtained. It requires 8 cu.m. of wood to furnish the same number of heat units as 1 ton of coal, and the wood costs ordinarily about $1.50 per m. on the tender. The service obtained with wood, however, is far inferior to that with coal, and on long hard climbs it is impossible to keep steam pressure up to maximum-load requirements. It has been determined by tests with engines now in use that, with wood fuel, the rating for any engine for any ruling grade should be fixed at 90% of the rating when using coal. The locomotives are, of course, adapted to use either coal or wood.

Up to the present time no coal of a quality fit for use has been discovered in Brazil. On the other hand, the country abounds with hydro-electric-power possibilities. It is probable that good coal will ultimately be discovered, and oil may be introduced; but the real solution of fuel problems is the development of the available water powers.

The Sao Paulo Ry. is shortly to electrify its mountain division between Sao Paulo and Santos, and the Parana Ry. will ultimately electrify its serra, to comply with its contract with the Government. These mountain divisions are the logical starting points from which this work will spread to the other parts of the system.

The "chief engineers of the line," "chief engineers of motive power" and some of the other divisional chiefs of the different roads that make up the Brazil Ry. are at present mostly Germans who have grown up with the roads. They immigrated years ago to Brazil, engaged in the construction and have, with characteristic perseverance and steadiness, remained with the roads.

The general officials, superintendents of the various roads and the engineers have been mostly foreigners, principally Americans, and most of the present higher officials are of the latter nationality.

Railway-Labor Conditions

There are no labor unions in Brazil. The great majority of enginemen and a considerable number of conductors are of foreign extraction, the enginemen being principally German, Italian and French, with some Austrian and a few English. There are, of course, Brazilian enginemen, but on the lines south of Sao Paulo they are in the minority. The pay of enginemen is from 200 to 300 milreis per month, which amounts under the normal rate of exchange to an average of about $80. Houses are usually provided.

Conductors are mainly native Brazilian, although there is a sprinkling of foreign born also. The average pay for a conductor is about $60 per month, and of flagmen, brakemen, etc., from $30 to $40.

There are no "16-hr." laws or any limitations of time spent on the road; but there are laws that there shall be a switchman at every main-line switch stand as the train passes, and the number of brakemen per train is greater than here, as a result, no doubt, of the exclusive use until recently of hand brakes.

The staff system of train orders and operation is in use, blocks being established from station to station, with the station agent acting as dispatcher for his block. This will undoubtedly be changed as soon as traffic warrants.

Track labor is composed of both natives and immigrants; all nations are represented. Day labor receives normally about $1 per day, section houses and firewood being provided. Section foremen receive about $40 per month, and the position that corresponds to supervisor of track in the United States pays $90 to $100, houses being in all cases provided by the company.

The general rule with respect to the amount of track labor employed is 1 man per km. of track, and the Government engineers usually insist upon this standard.

The sections, as a rule, are from 6 to 8 km. long, and sometimes 10 km., short sections being favored, as neither hand-power nor motor cars are used, the hand push-car being used exclusively by section gangs.

Land and Colonization Department

As part of the concessions of the Brazil Ry. granted by the Government, immense tracts of land in various states were turned over to the railway, some of which the lines run through and some of which are hundreds of kilometers from any railroad.

Such blocks of land have been conceded in Matto Grosso, Parana, Santa Catharina and Rio Grande do Sul and are used by the company for colonization and agricultural experimental purposes. Some are being developed by certain subsidiary companies mentioned later.

The railway has a well-organized land and colonization department, which devotes its energies to obtaining set-

tlers and looking after them and developing the lands of the company. The Government has also established a number of colonies in various states.

Unusual inducements are made by both the Government and the railway to immigrants who bring their families and take up land. Their ocean transportation is, in most cases, paid; they are carried over the railroads free of charge, with their tools and effects, from the seacoast to wherever they intend to settle and are assisted or conducted by a representative of the railway or Government to their destination. They are then given a lot or parcel of land, which is to be paid for in one year or two years or more, as the case may be; and enough tools and provisions are advanced them to carry them over their first season.

The Brazil Railway Co. has initiated several subsidiary enterprises of large extent. The Brazil Lumber and Colonization Co., capitalized at about $5,000,000, has been cutting and sawing lumber in the states of Parana and Santa Catharina, where it has one very large modern plant and two smaller ones. It cuts principally Parana pine and some of the hardwoods. This company forms colonies to settle up the land on which the timber has been cut and has established a settlement at Tres Barras.

The Brazil Land and Cattle Co. is utilizing great tracts of land in the states of Parana, Sao Paulo and Matto Grosso for cattle raising. It has introduced blooded stock from the United States to form a nucleus upon which to build up a line of better cattle than that native to Brazil. The company is, in addition, interested in a packing plant in Sao Paulo, which is being erected by one of the large American packing houses.

Warning to American Engineers

Finally, a word to American engineers who desire to try their hand in South America: I am firmly convinced that South America from Sao Paulo south will experience a wonderful growth in the next few years. It is a marvelous country in many ways, undeveloped and abounding in opportunity. The freedom of its plains and the immensity of its wooded wilds inspire in one a desire to work and build. I suppose it is the instinctive spirit of the pioneer on the frontiers of civilization. And yet it is a mistake to rush off to it, unprepared in finances or language or knowledge of the ways of living there.

With a capital of a few thousand dollars a man can go there and pay for his experience while laying the foundation of his business; but to the engineer who is looking for a job my advice is strongly against going there expecting to find it. The good salaries go only to those who are sent there, to build and operate industries, by outside interests that are willing to pay for the man's first year of experience; for to the company employing him almost any man is practically a dead loss for the first year, or until he can acquire a knowledge of the language, the people and their ways of doing business. Certainly the most helpless of mortals is a person stranded in a strange land, unable to speak the language and knowing nothing of the people around him. Much useful knowledge can be gained at home by close study.

The moneyed interests of this country are becoming more and more impressed with possibilities in South America. These corporations are the means by which American engineers may fulfill their desire for a South American career.

Mississippi River Stages, 1915, and Hydrograph, 1861-1914

By James W. Skelly*

The stages of the Mississippi River at St. Louis during the summer of 1915, and January, 1916, were remarkable in many respects, particularly in the frequency and long duration of high stages. While not equaling the extremes of former years, notably the extreme high stage (38 ft.) of June 10, 1903, or the more famous flood stage (41.5 ft.) of June 27, 1844, there is nevertheless presented the very unusual and unprecedented occurrence of five distinct rises within three months—two in June, one in July, two in August—and a sixth in January, 1916, all of which slightly exceeded the "bank full" stage (30 ft.).

The crest on Aug. 22 (see accompanying hydrograph) followed the widespread rainfall of the Gulf storm that wrought so much havoc at Galveston. The crest of January was the result of heavy local rains augmented by a flood in the Illinois River, a tributary, and is remarkable, not only for its occurrence at a time when the Mississippi is usually very low, but because of the limited upstream range of its influence.

Before considering the diagram a few words may be said regarding the gage records for the period from Jan. 1 to Feb. 10, 1916, which have become available since the diagram was plotted. These figures are as follows:

Date	Reading	Date	Reading
Jan. 1	4.0	Jan. 22	7.7
2	5.7	23	13.5
3	11.0	24	20.5
4	15.2	25	23.8
5	15.6	26	23.8
6	14.9	27	23.7
7	13.8	28	26.1
8	12.3	29	28.0
9	11.0	30	30.0
10	10.6	31	31.4
11	10.2	Feb. 1	31.3
12	11.2	2	30.8
13	15.8	3	29.7
14	18.4	4	27.8
15	17.4	5	25.8
16	15.4	6	23.5
17	14.0	7	21.1
18	12.2	8	18.7
19	9.1	9	16.4
20	7.3	10	15.0
21	6.8		

At the crest, Jan. 31, 1916, the Missouri River, the principal tributary above St. Louis, was at mean or ordinary stage at Lexington, Mo., only 340 mi. above St. Louis, and was frozen over at St. Joseph, 500 mi. above; the upper Mississippi River at Dubuque, Iowa, 430 mi. above, was also at mean stage and frozen. The rises and crests of July, August and January established new high records at St. Louis for almost the entire periods July 22 to Aug. 29 and Jan. 27 to Feb. 8.

The accompanying comprehensive hydrograph, showing the daily stages at St. Louis for 1915, shows also the extremes for all years from 1861 to 1915, including, in addition, the famous flood of 1844 and the lesser one of 1858, the courses of both of which above the 30-ft. stage are shown because of their historic interest in the middle Mississippi Valley. The flood of 1858 (37 ft. on the present St. Louis gage), although lower at St. Louis than the 1903 flood, was higher at other near-by places both above and below that city, the greater local height of the 1903 flood being due to the contraction of the waterway by the construction of levees and other similar embankments in the vicinity of St. Louis.

*United States Assistant Engineer, Custom House, St. Louis.

The extreme high and low daily stages shown on the hydrograph are the extremes for each day in the year; and the mean high and low daily stages, 25.9 and 3.9 ft. respectively, are the means of the foregoing extremes—365 in each case. The mean high and low yearly stages, 26.9 and 2.2 ft. respectively, are the means of their respective extremes for each day throughout the period covered by the hydrograph—54 years. The mean stage of river, 12.4 ft., is the mean of all daily stages. The curve of mean daily stages shows the mean for each day in the year, and the high and low normal limits indicate means in their respective zones. There is also shown the curve of river discharge at St. Louis, derived from about 500 observations, covering a period of 50 years.

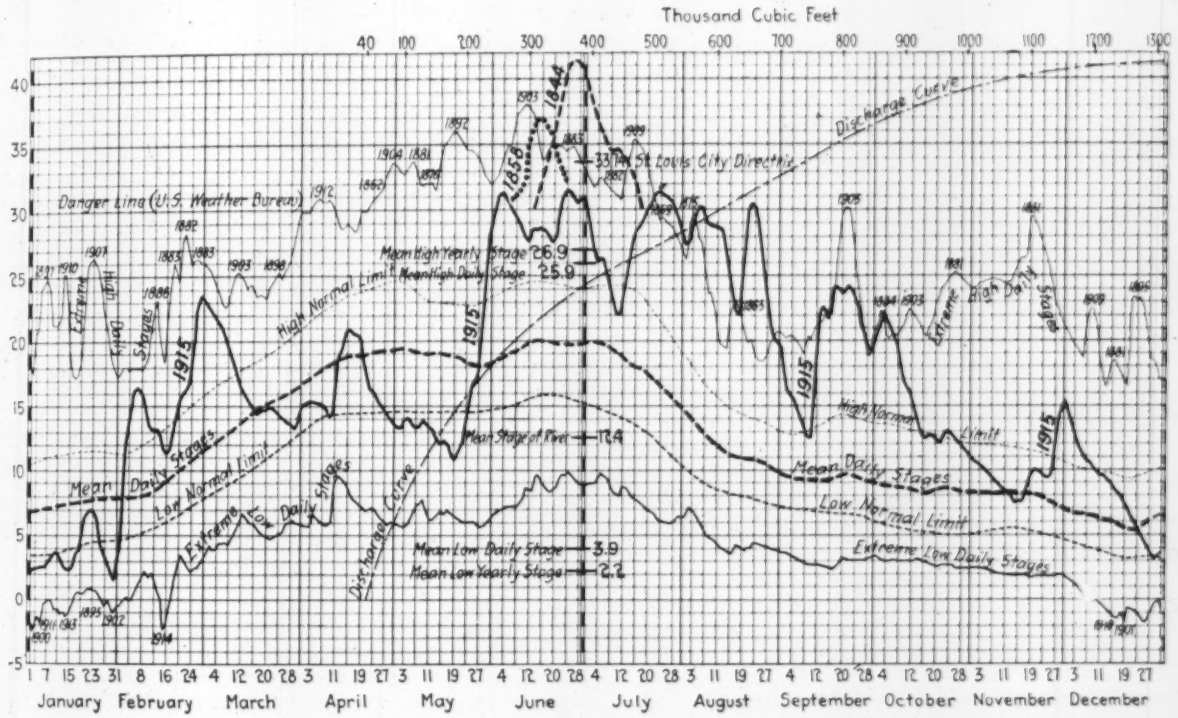
Fusible Plugs Investigated by Bureau of Standards

Fusible plugs in steam boilers are usually screwed through the steel heating surface of the boiler an inch or so above the line at which low water in the boiler begins to be dangerous. So long as the plug is covered with water it remains intact; but when the water level falls below the plug, the metal is melted by the heat of the fire, and the steam blowing through the opening gives warning of the dangerous condition.

While fusible plugs have been in widely extended use since the middle of the last century, they have often failed to operate in the manner intended and have consequently become more or less discredited by engineers. Their use is required on the boilers of all American merchant vessels; but they are not used in the United States Navy, nor are they generally used in marine boilers abroad. They are extensively used in this country in locomotive and stationary boilers and in portable boilers.

The Bureau of Standards has recently conducted an exhaustive investigation into the causes of the failure of fusible-tin boiler plugs, and a report on the investigation has been issued as No. 53 of the bureau's technologic papers. The investigators found that the cause of the failure of fusible-tin boiler plugs has generally been the presence of lead and zinc as impurities in the tin. Even very small percentages of lead and zinc impurities may cause the plug to fail to operate as it should after some months of exposure to heat and oxidizing influences. The bureau recommends that specifications for fusible plugs should require the tin to be at least 99.7% pure and to contain not more than 0.1% of lead and 0.1% of zinc. Even purer tin than this is obtainable in the market and might well be specified for such plugs.

Comparing these requirements with present standard specifications, it is of interest to observe that the specification of the Boiler Inspection Department of the Interstate Commerce Commission totally ignores the purity of the tin. The specification contained in the standard boiler code recently adopted by the American Society of Mechanical Engineers calls for tin that will melt between 400° and 500°; but this specification is of no value, since it will admit tin containing as much as 65% of lead or 15% of zinc. The Federal Steamboat Inspection Service is to revise its specification to conform to the recommendations of the Bureau of Standards.


Thousand Cubic Feet
Discharge Curve
Danger Line (U.S. Weather Bureau)
Mean High Yearly Stage 26.9
Mean High Daily Stage 25.9
High Normal Limit
Mean Daily Stages
Low Normal Limit
Extreme Low Daily Stages
Mean Stage of River 12.4
Mean Low Daily Stage 3.9
Mean Low Yearly Stage 2.2
January February March April May June July August September October November December

MISSISSIPPI RIVER HYDROGRAPH, ST. LOUIS GAGE, 1861 TO 1914, AND STAGES FOR 1915

The Tansa Dam, which impounds water for the supply of Bombay, India, has been raised from a height of 118 ft. to 126½ ft. as a part of a project to increase the water-supply. The enlarged works were dedicated on Dec. 8, 1915. The dam is of masonry and had an original length of 1½ mi. By adding 8½ ft. to its height its impounding capacity was increased from 21,600,000,000 to 32,400,000,000 gal. The raising of the dam was completed in May, 1915. Particulars of the whole project are given in the London "Surveyor" for Jan. 7, 1916.

Tar-Coated Concrete Pavement in Ann Arbor, Mich.*

By Manley Osgood†

The more or less famous Ann Arbor tarred-concrete pavement is a concrete pavement, usually laid in two courses, with a carpet coating of tar and sand placed as soon as the concrete is sufficiently cured. This type of pavement originated in Ann Arbor in a peculiar way. In 1907, during the construction of a new City Hall, a barrel of tar was accidentally spilled over a concrete walk. Sand was thrown into the tar to make the walk fit for foot traffic. The tar and sand adhered to the concrete, and the carpeting thus formed is intact today. This accident furnished the idea for the carpeted pavement.

The first pavement of this type was constructed on Maynard St. in 1909. It is one block long and contains 1,880 sq.yd. The materials were purchased, the work of construction was done by the city, and every precaution was taken to insure good results with the materials used. This pavement was laid for $1.03 per sq.yd., including curbing and grading, or for 78c. per sq.yd. for the pavement only.

When the news spread that this pavement had been constructed so cheaply, the petitions commenced pouring into the Common Council from all parts of the city; and all expressed a preference for "pavement similar to that on Maynard St." The result was that the city started paving streets as fast as was possible with the machinery and labor available. This can best be illustrated by the yardages laid during the succeeding years:

	Sq.Yd.		Sq.Yd.
1909	1,880	1912	11,540
1910	16,560	1913	33,460
1911	64,090	1914	11,630

The drop in 1912 was due principally to water-works agitation which developed that year and perhaps secondarily to the fact that a change was made in the City Engineer's Office in 1912. I assumed the office of City Engineer on June 17, 1912, coming from an Ohio city and having no assistants who held over from the previous administration. The drop in 1914 was due to a charter clause which provides that not more than $150,000 worth of paving bonds shall be outstanding at any time. This limit was reached in 1914, and now only so much paving may be done each year as will require a bond issue equal to those redeemed the previous year.

Attempts to Cheapen the First Cost

In 1910 two things happened that worked seriously to the detriment of the pavement laid in that year and in 1911 (which constitutes about 58% of all the concrete pavement now laid in the city). Bids were called for and received; but the City Council, on the advice of its officers, rejected all bids and ordered these officers to proceed with the construction on a force-account basis. The specifications under which bids were received called for a 5-in. lower course and a 2-in. top course of concrete. In order to insure a substantial saving in cost over the lowest bid received, the lower course was made 4½ in. thick and the top course 1½ in. thick, a total thickness of 6 in. instead of 7 in.

In 1910 also a patent was applied for, a company organized, and this type of pavement was advertised and promoted throughout the country. Low first cost was the most advertised feature, and the results obtained at Ann Arbor were used as examples of remarkable savings. The application for a patent (which was never granted) was made by a city employee with much authority in paving construction. As he received a royalty on every yard of this type of pavement licensed or constructed by the company promoting it, he was very materially interested.

In these two years, 1910 and 1911, everything was sacrificed to first cost. The small batch concrete mixer used on Maynard St. was replaced by continuous mixers of greater capacity. Cement was never tested, unless there was some reason to suppose that it did not come up to specifications. Bank-run gravel was used in both courses without screening or washing; and especially in 1911, when the greatest yardage was laid, there was not sufficient, or sufficiently competent, supervision or inspection to insure even the best obtainable bank-run gravel.

Many who are familiar with the paving operation that year have told of seeing lumps of clay or even of sod in the gravel, as it lay ready to be shoveled into the mixer. On one section, three blocks long, of a comparatively heavily traveled street with a car track in the center, a further saving was effected by building a one-course concrete pavement of 1 part cement to 5 parts of this same bank-run gravel. After the pavement was entirely completed, the number of sacks of cement used was checked against the yardage, and it was found that not sufficient cement had been used to make even a 1:5 mixture. I may say here that, although this section of pavement was constructed no longer ago than 1911, the city is now facing the proposition of surfacing it with some stable material or reconstructing it. The carpet coating will not adhere to this lean mixture.

No reinforcing of any type was placed in these concrete pavements, nor were the expansion joints protected in any way. Care was not taken to see that these joints were opened and clean to the full depth of the pavement, but sweepings from the concrete prior to carpeting were brushed into them and the remainder of the joint filled with tar and sand poured separately.

Experiments to Improve the Pavement

In 1912 the thickness of the pavement was increased to 7 in., with a 5-in. lower course and a 2-in. upper course, and care was taken to insure the best grade of bank gravel obtainable. In 1913 we commenced using a washed and screened sand in the top course, retaining the bank gravel for the lower course. Care was also taken to have an open expansion joint the full depth of the concrete, and these joints were filled with filler asphalt.

Many experiments were made to determine the best bituminous material for the carpet coating. Bermudez asphalt was tried, but in the winter time it became brittle and scaled from the concrete. All grades of coal tar were tested—from the crude product to that with considerable refining. The results indicated that the coal-tar product with only sufficient refining to drive off the water and lighter oils was best adapted to the conditions in Ann Arbor. The crude tar was purchased at the local gas plant and sufficient refining given it by heating to about 220° to 250° F., as it was applied to the concrete. During

*From a paper presented at the annual meeting of the Michigan Engineering Society.

†City Engineer, Ann Arbor, Mich.

1911 a bitumen was purchased from the Barrett Manufacturing Co., with about the same amount of refining as that company's lightest grade of Tarvia, but it showed no better results than the local tar refined.

Various methods of application were tried. At one time the only sweeping was done with a rotary broom. This was followed by a gravity tar spreader, which in turn was followed by an automatic sand distributor. At another time the pavement was swept by hand, the tar applied with pouring pots and squeegees and the sand spread with shovels. Various combinations of hand and machine work were used. The tar and sand were even applied to the concrete surface after sprinkling with water. The results obtained indicate that the surface to be carpeted should be thoroughly dry and free from dust and that the tar should be applied sufficiently hot to be in a thoroughly liquid state. Whether the tar and sand are applied by machine or by hand does not affect its lasting qualities so much as does the temperature of the concrete to which it is applied. The carpeting should be applied during hot, dry weather. A one-size gravel

RECENT PAVEMENTS IN ANN ARBOR

District No.	When Laid	No. Sq.Yd.	Total Cost	Total Cost per Sq.Yd.	Cost per Sq. Yd., Pavement Only	Kind
1-2	1898	12,730	$31,375	$2.46	$1.64	Brick on concrete
3	1899	5,140	11,645	2.27	1.73	Brick on concrete
4	1900	10,791	27,845	2.58	2.17	Asphalt block on sand
5	1902	12,484	31,778	2.55	2.16	Asphalt block on sand
6	1902	1,589	2,860	1.80	1.39	Brick on sand
7	1903	9,140	24,486	2.68	2.19	Asphalt block on sand
8	1903	2,431	6,490	2.67	2.19	Asphalt block on sand
9	1907	7,519	19,092	2.54	2.03	Bitulithic
10	1905	5,045	10,720	2.03	1.63	Brick on concrete
11	1908	350	672	1.92	1.50	Brick on concrete
12	1909	1,883	1,930	1.03	.78	Ann Arbor tar concrete
13	1910	1,159	1,351	1.17	.88	Ann Arbor tar concrete
14	1910	6,765	6,685	.99	.76	Ann Arbor tar concrete
15	1910	8,633	8,189	.95	.71	Ann Arbor tar concrete
16	1911	12,092	12,392	1.03	.78	Ann Arbor tar concrete
17	1911	2,587	2,672	1.03	.84	Ann Arbor tar concrete
18	1911	20,826	23,172	1.11	.78	Ann Arbor tar concrete
19	1911	10,117	11,110	1.10	.82	Ann Arbor tar concrete
20	1913	5,682	7,726	1.36	.93	Ann Arbor tar concrete
21	1911	10,483	11,678	1.12	.84	Ann Arbor tar concrete
22	1911	293	314	1.07	.84	Ann Arbor tar concrete
23	1911	920	1,029	1.12	.77	Ann Arbor tar concrete
24	1911	1,833	1,747	.95	.77	Ann Arbor tar concrete
25	1911	3,158	3,181	1.01	.78	Ann Arbor tar concrete
26	1912	2,407	2,703	1.12	.89	Ann Arbor tar concrete
27	1912	7,711	9,071	1.18	.91	Ann Arbor tar concrete
28	1913	15,612	20,836	1.34	.98	Ann Arbor tar concrete
29	1913	14,131	19,257	1.36	1.01	Ann Arbor tar concrete
30	1914	11,832	14,802	1.25	.98	Ann Arbor tar concrete
32	1915	2,085	2,740	1.33	.....	Reinforced concrete
33	1915	4,924	8,665	1.62	.....	Asphaltic concrete
34	1915	14,372	24,733	1.60	.....	Asphaltic concrete
35	1915	3,273	5,431	1.66	.....	Reinforced concrete

screening, between the ⅛-in. and ¼-in. screens, gives better results than were obtained with other sands and gravels tried.

The distance between transverse expansion joints was varied from 25 to 50 ft. The longer blocks developed a transverse crack approximately in the center. A spacing of 30 ft. between these joints was found best.

Property Owners Learn by Experience

As I have stated, after the paving of Maynard St. in 1909 the people of Ann Arbor were very enthusiastic about this type of pavement. It continued to grow in favor during 1910 and 1911. Then the tide commenced very slowly to turn. It became evident to all that it would be necessary to recarpet the concrete every two or three years and in some cases probably every year, varying with traffic conditions. Those who owned automobiles did not like the throwing up of tar and sand onto the under sides of the fenders. Owners of horse-drawn vehicles avoided the newly carpeted streets, and even pedestrians avoided the crossings. In some places where the carpeting peeled, the concrete commenced to ravel; and sections varying in size had to be cut out and replaced with better material. Then the one-course concrete section previously mentioned wore away rapidly, and two other streets laid the same year showed evidence of soon needing extensive repairs.

A majority of the people now realize that reducing the first cost to a minimum, together with insufficient inspection, has imposed a heavy burden on the community in the expense of maintenance, repair and reconstruction.

But this type of pavement did do one real good to the City of Ann Arbor. Prior to 1909 there were only 67,220 sq.yd. of pavement in the city, and property owners could not be persuaded to petition for more. In the two years following the completion of Maynard St. petitions were received for more than 200,000 sq.yd., some of which is not yet constructed. The introduction of this type of pavement—cheap in first cost—hastened the construction of sufficient pavement to make the property owners realize the economic value of the paved street. Now they are still petitioning for pavements, even though they realize that the first cost will be somewhat higher than was the cost of the tarred-concrete pavements. Furthermore, we should not have even the 231,000 yd. of paving that we now have, had it not been for the low first cost of most of it.

Tar Carpet for Asphalt-Block Pavement

The carpet coating of tar and sand has been put to other use in Ann Arbor than covering concrete. During the years from 1900 to 1903 a total of 32,500 sq.yd. of asphalt-block pavement was laid on some of the most heavily traveled streets in the city, with no other foundation than the compacted gravel soil. As early as 1908 it was realized that some measure must be adopted to preserve this pavement, and it was given such a carpeting. The success of this carpeting strengthened the faith in a carpeted concrete pavement, the idea for which had been conceived the previous year. The tar and sand adhere very well to the asphaltic surface of these block-paved streets, and the use of this carpeting has prolonged the life of these pavements for many years. On these streets one such coating lasts for about four years.

To summarize the advantages and disadvantages of a carpeted concrete pavement laid in the best possible manner: The cost of the coating of tar and sand just about offsets the cost of reinforcing and joint protection that would be necessary if the concrete were not to be protected by the carpeting. This carpeting waterproofs the surface and makes it less absorptive, therefore more sanitary. It also deadens the sound made by horses' hoofs on the unprotected concrete and does away with any sun glare from uncolored concrete. The disadvantages, which are due to the fact that the carpeting does not adhere well to the concrete, are the expense of maintaining and the annoyance of freshly tarred streets every summer.

Ann Arbor has learned its lesson. Concrete pavements, as a class, are not condemned. In fact, about 5,350 sq.yd. of reinforced-concrete pavement was constructed in Ann Arbor during the past summer; but the gravel used was washed and screened and remixed in a batch mixer, and every precaution was taken to insure the best materials and proper construction. The property owners in most cases are now willing to have the type of a proposed pavement decided by sound engineering consideration; but whatever type is constructed, they want only first-class materials and first-class work.

Bending Moment in Continuous Reinforced-Concrete Beams

By Raymond J. Roark*

In the design of a reinforced-concrete girder continuous over three or more supports, it is customary to solve for bending moments by the ordinary methods of continuous-beam analysis. The moments at points throughout the beam having been determined, the percentage of reinforcement at any section is made sufficient to care for the moment at that section. The amount of steel and hence the moment of inertia of the beam section are therefore not constant, but may vary considerably in each span; and the ordinary theory, based on the assumption of uniform moment of inertia, cannot be regarded as strictly applicable.

While it is possible to make a theoretically exact analysis, in which account is taken of the variation of moment of inertia, this is rarely done, nor indeed is such refinement generally warranted. It is of interest, however, to know how great the probable error due to the neglect of this factor may be. In the following discussion two cases are assumed and the maximum moments computed—first, by the ordinary theory as adapted to beams of uniform section, and second, by a more exact method taking into account the variation in moment of inertia.

A beam of rectangular section and of three equal spans will first be assumed. If the depth be taken constant, the amount of steel at any section determines to a large extent the moment of inertia at that section. Since the amount of steel is proportional to the bending moment, the moment of inertia of the beam section may be said to vary approximately as the bending moment. Now this variation is least for a beam carrying live-load only, and greatest for a beam carrying dead-load only. Therefore if a beam be designed for dead-load only, it will have the greatest possible variation in moment of inertia and so represent the greatest possible departure from the assumed condition.

Such a beam is shown in Fig. 1. The positions of the points of inflection are assumed to be the same as for a beam of uniform section, as this assumption is

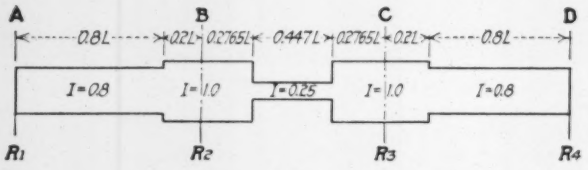


FIG. 1

Method of Computation	$R_1 = R_4$	$R_2 = R_3$	+M in First Span	−M at Supports	+M in Center Span
Usual method.	0.400W	1.10W	0.0800Wl	0.10Wl	0.025Wl
Exact method.	0.389W	1.111W	0.07566Wl	0.111Wl	0.014Wl
% error.....	2.8	1.0	5.7	10.0	78.0

made in design, and the moment of inertia is taken as constant between points of inflection and proportional to the maximum moment occurring in that portion of the beam.

The analysis is made by the method of redundant reactions. (A full explanation of this method will be found in Johnson, Bryan and Turneaure's "Modern Framed Structures," Part 2.) Reactions R_1 and R_4 are taken as redundant, and the deflection at the left end is placed equal to zero. The resulting equation is

$$\int_A^D \frac{M dx}{EI} m_1 = 0$$

where M is the true bending moment at any section and m_1 is the bending moment at any section due to an upward load of unity acting at A when the two redundant reactions are removed. M is equal to $M^1 + R_1 m_1 + R_4 m_4$, where M^1 is the moment at any section due to the load on the beam with the redundant reactions removed; m_1 is as previously defined, and m_4 is the moment at any section due to an upward load of unity acting at D when the redundant reactions are removed. Since the beam and the load are symmetrical, $R_4 = R_1$. M^1, m_1 and m_4 can all be expressed in terms of x and the above integration performed.

This integration must be performed first for the distance A to B in two parts, the limits being 0 and $0.8L$, and $0.8L$ and L; then from B to C in three parts, using limits 0 and $0.2765L$, $0.2765L$ and $0.7235L$, and $0.7235L$ and L; then from C to D, where the terms become equal to zero. Integrating as above and solving the resulting equation for R_1 it is found that $R_1 = 0.389W$, where W is the load on each span.

The table under Fig. 1 gives the values of all reactions and moments at the dangerous sections as determined by this method of analysis, together with the same quantities as found in the usual way—by the formulas for beams of uniform section.

It might be supposed that in the case of a T-beam the variation in moment of inertia and the resulting error in computed moments would be great owing to the fact that very different sections are opposed to positive and to negative moments. For this reason such a case will be considered.

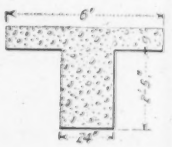


FIG. 2

It will be convenient to assume a girder of definite form, as shown in Fig. 2. The dimensions are taken from a railroad viaduct as actually constructed. It will be assumed that the amount of steel at the supports is just sufficient to give balanced reinforcement. Using values given by the Joint Committee specifications, the required area of steel is found to be 8.4 sq.in. and the resisting moment of the beam at working stresses 4,535,000 in.-lb. Assuming as before that the beam is to be designed for dead-load only, and on the assumption of uniform moment of inertia, we would have as the maximum positive moment provided for in the first span, $\frac{0.08}{0.10} \times 4{,}535{,}000 = 3{,}628{,}000$ in.-lb.; and as the maximum in the middle span, $\frac{0.0316}{0.10} \times 4{,}535{,}000 = 1{,}432{,}000$ in.-lb. Computing by T-beam formulas, we find that the steel areas at these points should be 6.48 sq.in. and 2.49 sq.in. respectively. The area of steel will be taken as constant between points of inflection, as formerly.

The moments of inertia are found from the transformed sections, the steel being replaced by an area of concrete 15 times as great. The concrete of the original section is not assumed to be effective in tension. Fig. 3 shows the beam as considered. The maximum moment of inertia is assumed as unity and the other values expressed as ratios thereof. The method of analysis is

*Instructor in Mechanics, University of Wisconsin, Madison, Wis.

exactly the same as for the first case, and the results are given in the table under Fig. 3.

In view of the fact that the above analyses assume a somewhat greater variation in moment of inertia than would be likely to occur in practice, it is probably safe to say that the greatest error due to the use of the ordinary theory would not exceed 50% in the case of the positive moments nor 10% in the case of the negative moments. The former error would be on the side of safety, the latter on the side of danger. In a beam of

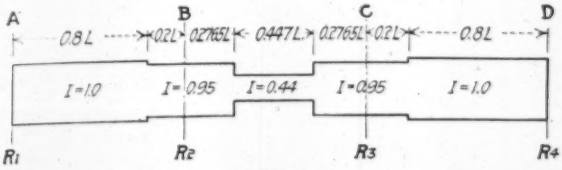


FIG. 3

Method of Computation	$R_1 = R_4$	$R_2 = R_3$	+M in First Span	−M at Supports	+M in Center Span
Usual method	0.4000W	1.10W	0.08Wl	0.10Wl	0.0250Wl
Exact method	0.3965W	1.1035W	0.07855Wl	0.1025Wl	0.0225Wl
% error.....	0.9	0.3	1.8	2.5	11.1

the kind here considered the concrete stress in the under side of the beam at the supports is generally the hardest to keep within specified limits, even when a higher compressive stress is allowed there than at other points. Some designers attempt to get around this difficulty by deepening the girder at these points or by providing compression reinforcement, or both. The effect is to increase still further the moment of inertia and hence the bending moments there. As a consequence the concrete stress is always likely to be higher than expected.

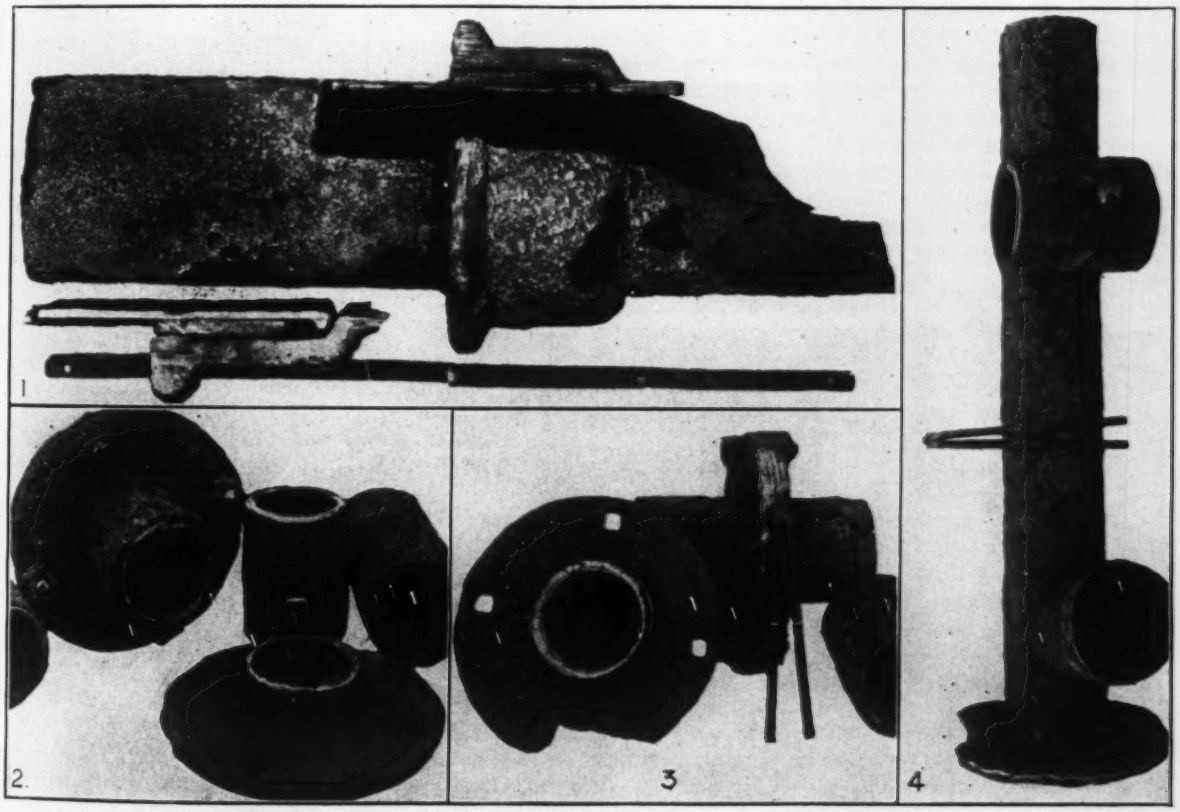
Relics of Early Water-Works

Philadelphia enjoys the distinction of having the first American municipal water-works to use cast-iron mains to any considerable extent. The earliest of these were laid in Water St. in 1804 as an experiment. The pipe was imported from England, at a time when popular prejudice against the use of iron pipes for potable water-supplies still ran high.

The accompanying illustrations show some of these early water mains, although none date to 1804. Fig. 1 shows some 6-in. bell and spigot jointed pipe laid in 1827 in Locust St., east of 8th St., which was removed in the latter part of 1915. The other illustrations show sections of some older 4½-in. flanged pipe laid in Chestnut St., between Broad and 15th St. in 1817. All this pipe was still in good serviceable condition and was removed only because in one case the main interfered with the construction of a new sewer, and in the other to install a larger pipe previous to laying a new pavement.

An analysis of the incrustations on the 1827 pipe is of interest. It was chiefly oxide of iron and sand, together with some organic matter. The exact chemical analysis was: Iron oxide (Fe_2O_3), 77.40; sand (insoluble matter, SiO_2), 7.85; moisture, 2.16; volatile matter (organic), 11.95; total, 99.36.

The older pipe was probably imported from England, but the 6-in. bell and spigot pipe very likely came from the foundry of Samuel Richards, established in Philadelphia in 1820. If cast in accordance with the specifications drawn by Frederick Graff in 1816, this pipe was only $\frac{5}{16}$ in. thick as originally laid in the ground.



FIGS. 1 TO 4. WATER-WORKS RELICS DUG UP RECENTLY IN PHILADELPHIA: IRON WATER MAINS AFTER NEARLY A CENTURY OF SERVICE

Fig. 1—A 6-in. bell and spigot pipe laid in 1827. Figs. 2, 3 and 4—Parts of a 4½-in. main laid in 1817

Tests of 18,000-Hp. Tallulah Falls Turbines

By E. Lauchli*

Tests of the 18,000-hp. vertical-shaft hydraulic turbines in the Tallulah Falls plant of the Georgia Railway and Power Co. (described in *Engineering News*, Jan. 29, 1914) were completed during the year past, and the results may now be recorded. The maximum efficiency of the three units tested was 88.01% and the average at 80% load was 87.82%.

The specifications required that each unit should develop 12,800 hp. at 514 r.p.m. under 580 ft. head, with an efficiency of not less than 83%. Each unit, see Fig. 1, consists of (1) a 10,000-kw. 6,600-volt alternating-current generator, with oil-pressure bearing and exciter carried on top of the generator, and (2) an 18,000-hp. turbine, with cast-iron scroll case, steel wicket gates, bronze runner and steel-lined draft tube. Oil for the pressure bearing is furnished by two pumps, each capable of carrying the load. One pump is mechanically driven from the main shaft of the unit; the other is driven by an electric motor.

Few hydro-electric plants have been designed so particularly with a view to rendering easy and accurate the recording of turbine-discharge measurements as has the plant under consideration. The specifications called for weir-discharge measurements to be made in connection with the efficiency tests, using the Francis formula corrected for the velocity of approach. The weir, installed in the tailrace of the plant, as shown in Figs. 2 and 4, is 30 ft. long, with end contractions. It was built of heavy timber carefully calked and carried on a concrete weir anchored and sealed into the substrata. Still boxes were provided at each end, connected with a perforated submerged pipe, 8 ft. above the weir, as shown in Fig. 4. Before carrying on the tests, the leakage from different sources was determined by measuring water over a 12-in. weir. The leakage did not exceed ¼ cu.ft. per sec.

The depth of water over the crest was measured with improved Gurley hook gages, located in the still boxes. As it was anticipated that water would pile up on the far side of the weir, readings were taken simultaneously in both still boxes, the actual discharge being computed from the average discharge as recorded in each still box.

*2 Wall St., New York City.

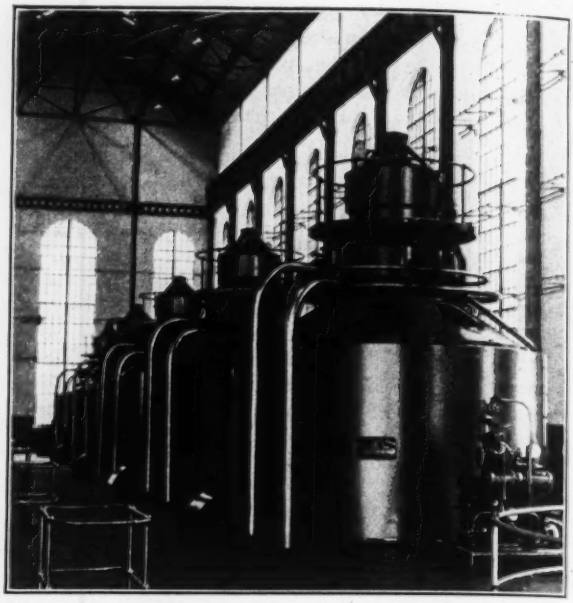


FIG. 1. 10,000-KW. GENERATING UNITS IN THE TALLULAH FALLS STATION

In general, readings of the recording instruments were taken independently by representatives of the power company and of the turbine manufacturers, the S. Morgan Smith Co. In order to make due allowance for the velocity of approach in the Francis formula for weir discharge, a cross-section of the channel of approach in the tailrace was taken 8 ft. above the weir, as shown in Fig. 4, and the additional head computed therefrom. Also, in order to gain an idea as to the distribution of the velocity of water in the channel of approach, velocity readings were taken with a Gurley current meter, 8 ft. above the weir, at various stations, the velocity curves obtained in the center of the weir for discharges of approximately 200, 250 and 300 sec.-ft. being shown in Fig. 4.

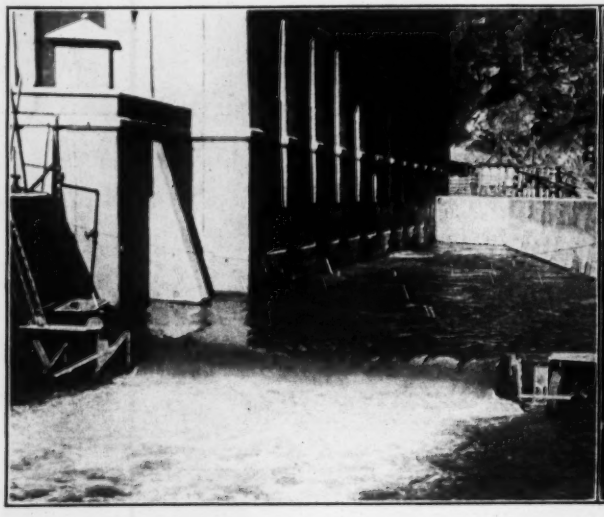


FIG. 2. TAILRACE WEIR AT TALLULAH FALLS

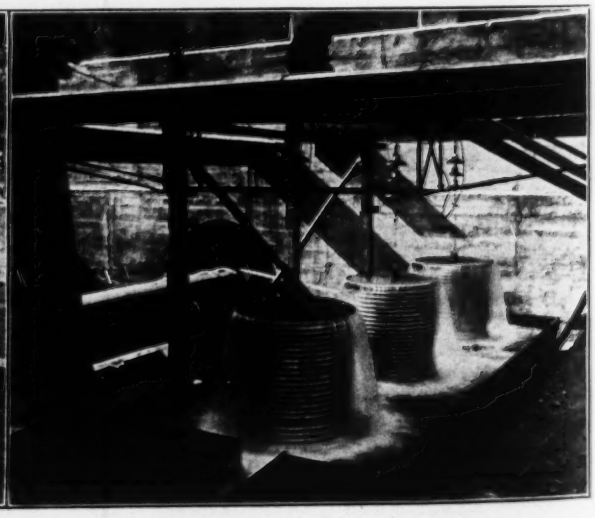


FIG. 3. WATER RHEOSTATS FOR GENERATOR LOAD

The weir measurements were checked with venturi meters, furnished by the Builders Iron Foundry and installed on the penstocks near the power house. Each meter has a large diameter of 60 in. and a 35-in. throat; the recording instruments comprise manometers giving instantaneous readings and a registering instrument making autographic charts. Pitometer measurements were made by the Pitometer Co., the recording instruments being installed at the throat of the venturi meters, where the flow is most perfect.

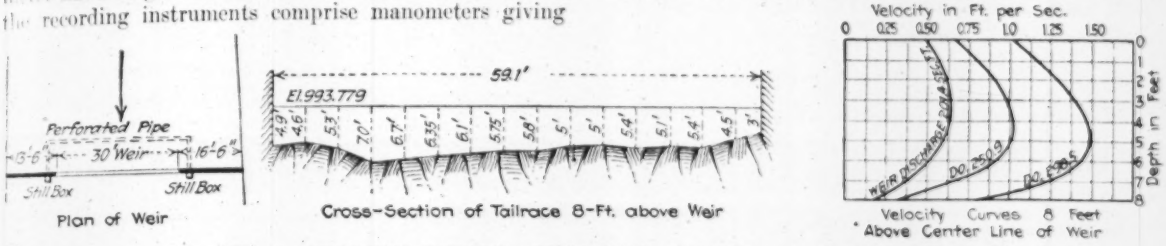


FIG. 4. VELOCITY CURVES ABOVE WEIR, TALLULAH FALLS PLANT

The net head on the unit tested was measured by at least two and usually three calibrated pressure gages located at the entrance of the scroll case. That the weir measurements were carried on successfully and carefully was subsequently proved by comparing the weir discharge with the corresponding discharge recorded with the venturi tubes and pitometers. The readings of the latter meters are not given here, but in general they were about 2 to 3% lower than the weir and venturi-meter readings. From the accompanying table it becomes evident that in general the weir readings are slightly lower than the venturi-meter readings, but the variation is small indeed, and always less than 1%. The venturi-meter readings check closely with discharges as computed by the Bazin formula for weir discharge.

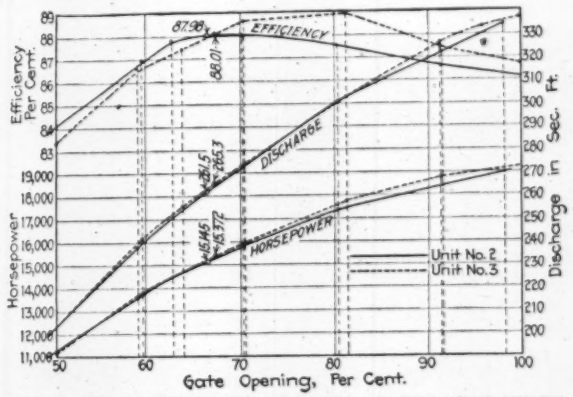


FIG. 5. CHARACTERISTIC CURVES OF TURBINE UNITS 2 AND 3
Referred to 580-ft. head

COMPARISON OF FLOW BY WEIR AND VENTURI METER

Test No.	Weir Discharge, Sec.-Ft.	Venturi-Meter Discharge, Sec.-Ft.	Difference, Sec.-Ft.
1	201.4	201.0	+0.4
	238.1	238.7	—0.6
	270.7	271.2	—0.5
	250.2	249.6	+0.6
2	204.0	205.0	—1.0
	241.7	242.0	—0.3
	271.75	273.0	—1.25
	254.7	253.0	+1.7
3	206.5	208.0	—1.5
	244.4	245.7	—1.3
	273.2	275.0	—1.8

The load on the generators was obtained by means of two three-phase star-connected water rheostats, Fig. 3, which gave approximately equal loads on the three phases at approximately unity power factor. Water for the rheostats was taken directly from the penstocks. All instruments used in the tests were checked in the laboratory of the Georgia Railway and Power Co. before and after the tests. During testing, the wiring of the electrical instruments used was run in as careful a manner as possible in order to avoid all stray-field errors. The generator losses on each generator used were obtained from tests by the General Electric Co. at its factory. Readings were taken simultaneously at all points, at one-minute intervals, the starting time being given by flashing all station lights. At least five accurate readings with steady load were taken at 50%, 60%, 70%, 80% and 90% gate opening, also as many readings at 100% gate opening as were necessary. The characteristic curves of two units, as tested, are given in Fig. 5. The maximum efficiency was 88.01%, and the average 87.82% at 80% load, for the three units tested.

Mississippi Water Terminals

River ports and water terminals were discussed at the second annual meeting of the Mississippi Valley Terminal League, held at St. Louis, Mo., Feb. 16. It appears that of 36 river ports all but two own some part of the waterfront. At 22 of these ports no water terminals are being built, while 14 have them or are building them.

Minneapolis, Minn., has built 1,300 ft. of municipal dock wall and has authorized a bond issue of $75,000. Davenport, Iowa, has spent $177,000 on works estimated to cost $1,000,000 when completed. The amount is raised by 4% municipal bonds, and the plant is made self-supporting by means of rentals and leases. Muscatine, Iowa, is spending $35,000. Hamilton, Ill., has a dock that was built for it by the Mississippi River Power Co. at a cost of $6,000. Kansas City, Mo., has built a municipal dock and authorized a bond issue of $75,000. Baton Rouge, La., has accepted plans for the first unit of proposed terminals, to cost $75,000. New Orleans, La., is spending $2,000,000 raised by bonds.

St. Paul, Minn., has plans under consideration for work estimated to cost $50,000. At Des Moines, Iowa, some work is being done. At Keokuk, Iowa, the preliminary filling is being done on the waterfront. Peoria and Quincy, Ill., propose bond issues of $100,000 and $75,000 respectively. St. Louis, Mo., proposes two municipal docks with railway connections, to be provided for by a bond issue of $2,000,000. At East St. Louis, Ill., about $75,000 is being expended, the amount being raised by private enterprise.

More detailed information regarding many of the projects was given in *Engineering News*, June 3, 1915.

Concrete Highway Trestle

SYNOPSIS—The longest concrete highway trestle ever built is probably that which the California State Highway Commission has nearly completed near Sacramento, over 3 mi. in length. The trestle has been constructed on the unit system. It is built with precast concrete piles, and the floor is made up of four separate precast slabs placed side by side to span the space from bent to bent. The methods of piledriving, transportation and erection used were unique. This substantial concrete structure, 20 ft. in height with a roadway 21 ft. in clear width, has cost about $130,000 per mile.

The Sacramento River, a stream of moderate size during California's long dry season, becomes during the spring floods, when the melting snows in the Sierras pass down the valley, one of the largest rivers of the United States. A flood flow of over 800,000 cu.ft. per sec. has been recorded. This volume of water is several times as great as the regular channel of the Sacramento will carry. The project for the reclamation and flood protection of the Sacramento Valley therefore provides for leaving a broad channel down the valley unobstructed by dikes. Into this channel, known as the Yolo bypass, the surplus water from the main channel will be discharged in time of flood.

The California State Highway Commission in constructing a state highway across the Sacramento Valley had to plan a road which should not be interrupted at periods of flood, which often last for several weeks. It was necessary therefore that the roadway across the Yolo bypass should be built above flood level and that it should not obstruct the flow of water down the channel.

It was decided that the best and most economical structure to carry the roadway across this channel was a concrete trestle. At one end, however, the final limits of the bypass channel are not positively determined, and at that end it was decided to build a wooden structure on creosoted piles, which would cost less and be more readily removed in case of necessity than a concrete structure.

The ground crossed by the trestle is a swamp of uniform character, so that it was possible to drive piles accurately and space the bents uniformly. It was decided that the concrete trestle should be built by driving precast concrete piles, four piles to a bent, molding a concrete cap on the heads of each bent and then placing precast floor slabs on these bents, leaving the parapet of the structure and the wearing surface for traffic as the final steps in construction. The work of constructing the trestle is described in detail as follows from information given by B. C. Gerwick, the resident engineer in charge of the work.

Layout of the Concrete Casting Yard

As may be seen by the accompanying sketch map, the west end of the trestle intersects the main line of the Southern Pacific. A spur track was built here, and bunkers were erected with a capacity of two carloads of sand and four carloads of rock. The railway delivered sand and rock in bottom-dump cars which discharged into a hopper under the track, and a bucket elevator hoisted the material into the bunkers. A yard was laid out for casting the piles and floor slabs. The concrete piles, 32 to 50 ft. long, weighed from 3 to nearly 5 tons, according to their length; and the floor slabs weighed 5¼ tons for the inside slabs and 6¼ tons for the outside slabs.

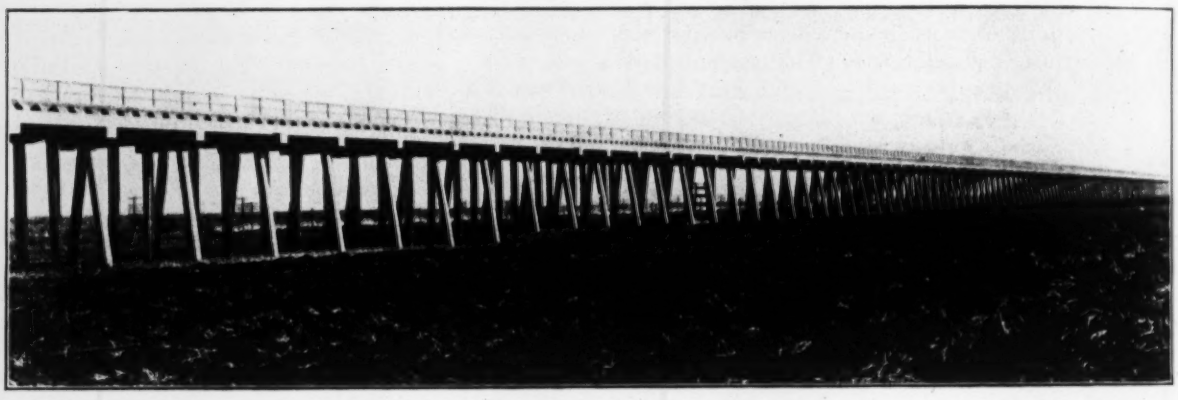


FIG. 1. VIEW OF COMPLETED TRESTLE ACROSS YOLO BYPASS

Corrugated steel was used for reinforcement and was all assembled in units before placing. This work was very accurately done, and the cost was comparatively low. The average cost of bending, assembling, and placing in the forms was about $7.50 per ton, and some work was done as low as $6.80 per ton.

Methods Used in Piledriving

Each bent of the concrete trestle has four piles, the two inner piles vertical and the outer piles driven on a batter of 1:8. The concrete piles used are 14 in. square with chamfered corners. There is a reinforcing rod at each corner and spiral hooping. The lower 5 ft. of the pile is tapered. Prior to the driving of the piles, numerous test borings and test piles were put down along the line of the trestle. An attempt was made to have all the concrete piles of such a length that they could

be driven to the desired grade and afford a resistance to permit a safe loading of 20 tons each.

Piles of five different lengths were cast, as follows: 32 ft. long, 860; 35 ft. long, 1,084; 50 ft. long, 521; 45 ft. long, 236; 50 ft. long, 220. By using these piles of varying lengths it was possible in nearly all cases to drive a pile to the final grade desired and obtain the required resistance. The soil encountered was a mixture of sand and clay, with some adobe on top, and varied considerably in bearing power. The penetration under the final blow in some cases was as much as ½ in.; but in others the last 20 or 30 blows lowered the pile only an inch, and in a very few cases it was necessary to cut off the piles.

The contract for the work was let July 31, 1914, and a month later the machinery was being set up. The first equipment arrived at the casting yard on Sept. 5. Pile-driving began on the creosoted wood-pile trestle at the west end on Nov. 1, and the first concrete pile was driven on Jan. 3, 1915. The last concrete pile was driven Oct. 1, 1915.

Methods of Handling the Piledriver

The piledriver used was 60 ft. high with swinging leads. When the work began, the swamp to be crossed by the trestle was dry. This swamp on the line of the trestle is almost a dead level, the elevation varying only from +12.5 to +8.6 in the 3¼-mi. length of the trestle. The desired elevation of the top of the concrete piles was 28.9, so the trestle floor is 16 to 20 ft. above the ground. To carry the piledriver over the soft swamp, 12x12-in. by 24-ft. skids were laid directly on the ground with 2x6-in. greased ways on these for the piledriver to slide on. The driver was backed away from the trestle as it worked, and the skids were pulled ahead with a team.

In February the swamp was flooded and a different method of working became necessary. A temporary wooden trestle was then driven ahead of the concrete trestle to carry the piledriver. This temporary trestle had bents placed 9½ ft. apart, four piles to each bent, and the piles were driven 8 to 12 ft. into the ground and projected about 8 ft. above the ground, which was enough to keep the caps clear of the water. A small piledriver drove the piles for this temporary trestle and placed the caps and stringers. The large piledriver, when it moved back from driving a bent of concrete piles, pulled the piles of the two temporary bents which it had passed over, and the piles, caps and stringers were floated ahead to the small driver.

Cushioning the Hammer Blow on the Pile

There were four ⅞-in. reinforcing rods in each concrete pile, and they were left projecting 20 in. above the head when the pile was cast, to make a proper bond with the concrete caps, which were later cast in place. These projecting rods necessitated special arrangements in driving the piles to avoid bending the rods. Immediately on top of the piles was placed a 4-in. fir block, or in case of the long piles two blocks, through which holes had been bored for the projecting rods. On top of this wooden block was placed a structural-steel head with a sliding cast block. Later a cast-steel head was used, holes being cored through it to admit the rods. On top of this cast-steel follower was placed a 14x14-in. block

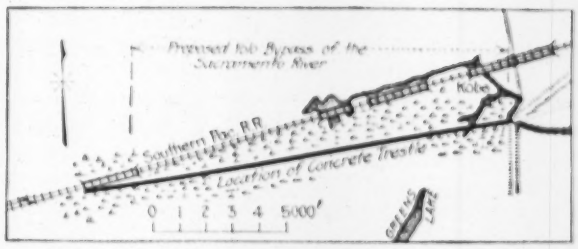


FIG. 2. SKETCH MAP, SHOWING LOCATION OF CALIFORNIA STATE HIGHWAY ACROSS YOLO BYPASS

of Australian ironwood, to receive the blow of the hammer. This block, chamfered at the upper end and fitted with a cast-steel cap, shattered rapidly under the shock of the hammer, lasting from one to five days, or a maximum of about 100 piles driven. It was found that when the fiber of the block broke down, much of the force of the hammer's blow was lost.

The concrete piles withstood the shock of driving in splendid shape, very few of the pile heads breaking down. When any of them did break, it was generally easy to find the cause, such as the head being out of square, or the cushion block too hard.

A drop hammer was used for driving the creosoted piles and was tried on the concrete piles, but the piles shattered badly under it. A No. 1 Vulcan hammer was then substituted and worked well. This ram weighed 5,000 lb., had a drop of 3½ ft. and struck 56 blows per minute.

As the concrete-slab floor units were cast of uniform length, it was necessary to drive the piles very accurately. The piles were lined up with transits, one on the center line of the bridge and one on a parallel base line. When

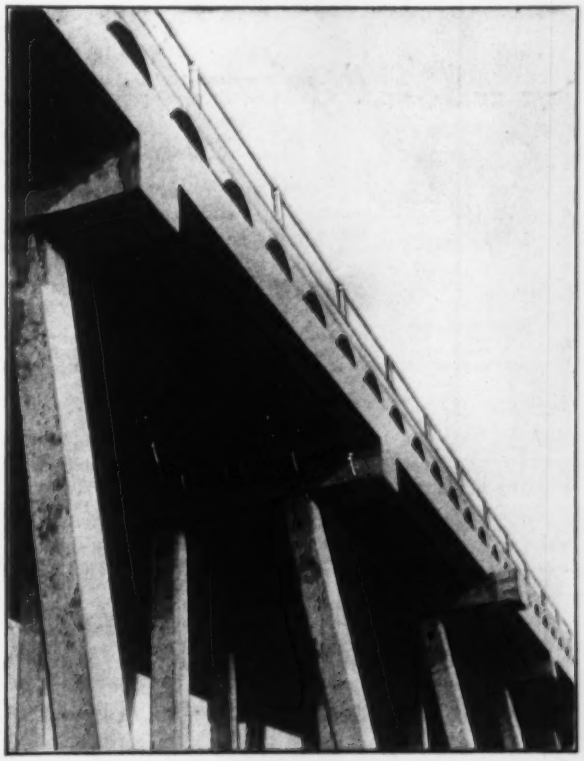


FIG. 3. VIEW OF UNDER SIDE OF YOLO BYPASS TRESTLE, SHOWING FLOOR CONSTRUCTION

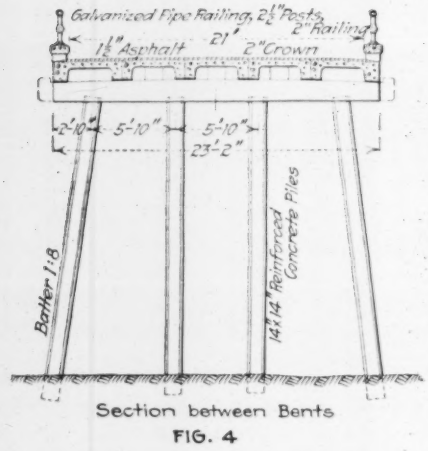
the ground became flooded so that the transit on the base line could not be used, direct measurement was relied upon to obtain the distance to the head of the pile. This spotting of the piles was done very rapidly, as may be seen by the fact that 30 to 32 piles of 35-ft. length were usually driven in 8 hr. The driver had also to pull the temporary trestle. The alignment of the piles is remarkably good. The maximum allowable variation of the head of the pile in the cap was 2 in. Only a few piles had to be sprung slightly to come within this variation.

As every engineer knows who has had to do work involving the use of long precast reinforced-concrete piles, it is essential that they be carefully handled to avoid excessive bending stress. The piles after being thoroughly seasoned in the yard were hauled out at night to the end of the completed trestle. In order to handle these handled directly to the driver. All the longer piles were lifted with two lines, one being attached well back from the head of the pile and a second at the rear quarter-point.

Temporary Track for Handling Material

As soon as a bent of four concrete piles was driven, a temporary deck was placed on the two south piles. The deck consisted of a 10x12-in. cap bored to admit the rods projecting from the heads of the piles and on this cap rested stringers spanning the 20-ft. space from bent to bent, while on these stringers were laid crossties and 18-lb. rails for a 3-ft. gage track. On this railway ran the cars which brought the piles and other construction material to the end of the work.

The next operation was the casting of the reinforced-concrete cap on the north half of the pile bent. Wooden



Section between Bents

FIG. 4

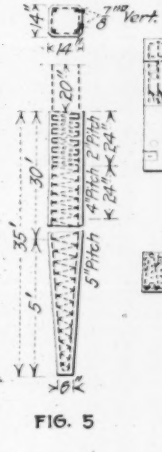


FIG. 5

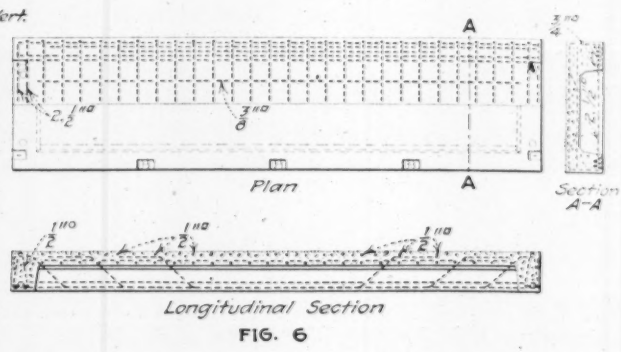


FIG. 6

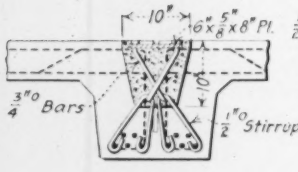


FIG 7

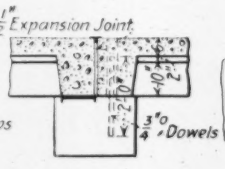


FIG 8

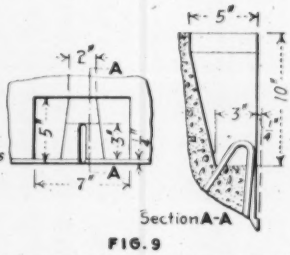


FIG. 9

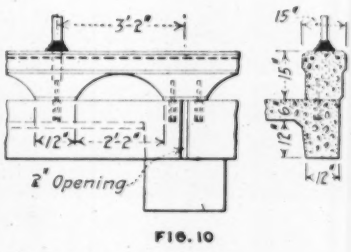


FIG. 10

FIGS. 4 TO 10. VARIOUS DETAILS OF TRESTLE CONSTRUCTION, YOLO BYPASS, CALIFORNIA

Fig. 4—Cross-section. Fig. 5—Reinforcement of 35-ft. pile. Fig. 6—Plan and sections of outside floor slab. Fig. 7—Slab connections at junctions over trestle caps. Fig. 8—Details of expansion joints. Fig. 9—Loop for lifting and anchoring floor slabs. Fig. 10—Longitudinal elevation and section of wheel guard

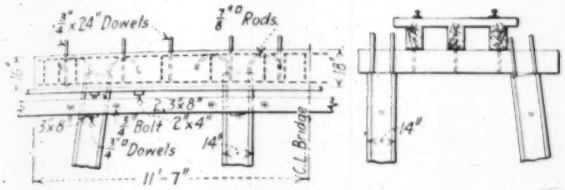
long piles, the piledriver was equipped with a 12x12-in. boom 48 ft. long, the inner end of which was set in a foot block between the standing leads of the driver. The swinging leads were so arranged that they could be swung to one side out of the way. When the boom was to be used for handling piles, the hammer line was used as a boom line and the pile line as a fall line, while a line to a niggerhead was used to swing the boom.

At first the piles were hauled from the yard to the end of the trestle at night and lowered by the boom on two horses placed beside the trestle, so that the piles were parallel with the bridge, the piles resting on the horses at about their quarter-points. Later, when the swamp was flooded, this plan was changed, and the piles were hauled out to the end of the trestle in the daytime and forms were built around the heads of the piles, which were allowed to project 6 in. into the cap. The rods projecting from the top of the piles were bent over into approximately semicircular form. The other reinforcing rods were placed in the form and left projecting toward the south end. The half-cap was then concreted. This work was done at night, the mixer and concrete material being carried on the temporary track on the south half of the trestle, which had to be kept open for delivering piles to the driver during the day.

These caps were allowed to season for 30 days, and then the two floor slabs for the north half of the floor were brought from the yards, set in place on the caps and grouted. The temporary track was then removed from the south half of the trestle, and the ties and rails were

relaid on the floor slabs of the north half. It was then possible to cast the south half of the trestle caps. After these had seasoned for 30 days, the floor slabs were brought forward and placed upon them.

As may be seen from the accompanying drawings, each floor slab has the general form of an inverted box. The



Caps are first poured on North Half of Bridge
All Work from Deck of Bridge Concrete mixed in Mixer on Car on Track, deposited in Form by Means of Chute Concrete placed Nights when Track was clear

FIG. 11. CROSS-SECTION, SHOWING CONSTRUCTION OF NORTH HALF OF CAPS OF PILE BENT

floor is 6 in. in thickness, with projecting flanges of a total depth of 18 in. Great pains was taken in the design of the slabs and caps, so that the completed trestle is a monolithic structure, although the separate parts are assembled as precast units. Rods were left projecting from the top of the trestle caps, and 3-in. holes were cored in the floor slabs, so that as the floor slabs were set they dropped over these rods. The holes were later filled with grout. For convenient handling of the floor slabs, four round-iron links were cast in each and were set in slots at the ends of the slabs. After the slabs were set in place these links were connected by hook bolts and a plate, and then the whole slot was filled with grout.

The sides of the slabs were made flush at the bottom for a depth of 4 in. and recessed ¼ in. above. When the slabs were set in place, a half-inch opening closed at the bottom was thus left between adjacent slabs, and this was later filled with grout.

At every third bent of the trestle was placed an expansion joint. Here of course the connecting hook bolts referred to were omitted. A half-inch opening was left in setting the slabs, and in this opening was inserted a fold of No. 16 galvanized iron. The expansion slabs, like all the other floor slabs, were bedded in cement mortar, which was applied to the trestle caps before the floor slabs were set. Movement takes place, however, between the mortar and these slabs at the expansion joints. The bottom of the slab is very smooth and somewhat oily from the forms, so that it slides readily on the mortar layer on top of the trestle cap. The movement in this expansion joint is noticeable under even slight changes in temperature. The highest temperature since the slabs have been set is 113° and the lowest 28°.

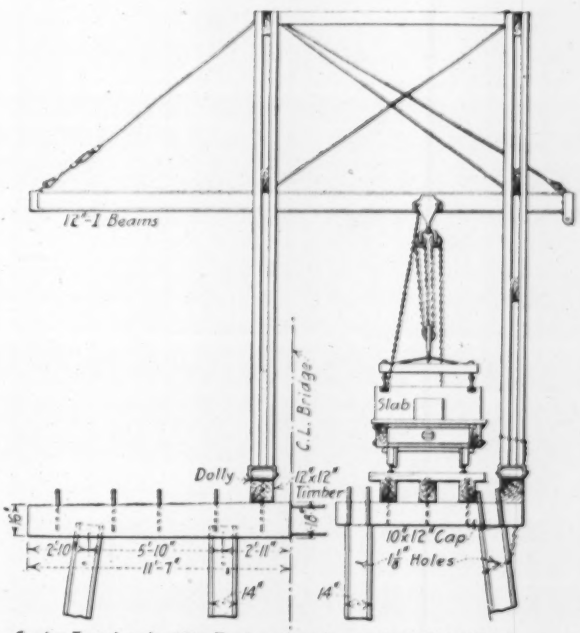
Equipment for Transportation of Material

For hauling the piles, slabs and other material from the casting yard to the end of the trestle, special cars were used, consisting of two sets of car trucks connected with a reach, and two 12x12-in. timbers set on top of the trucks. Two floor slabs made a load for one of these cars, and a train of three loaded cars was pulled by a gasoline locomotive. At the outset of the work one 5-ton gasoline driven locomotive was used; and as the distance of haulage increased, a similar 7½-ton engine was added. These gasoline locomotives worked three 8-hr. shifts and gave excellent satisfaction. While the grade on the concrete trestle was level, a temporary construction trestle extended from the yard on a 0.4% grade which the train had to ascend.

Parapets and Roadway Surfacing

For setting the slabs on the trestle cap a gantry crane traveler was used carrying two 5-ton chain blocks. When used to set the first row of slabs on the north side of the trestle, the traveler ran on 12x12-in. stringers which on one side rested on the inner end of the concrete cap and on the other side rested on the outer side of the cap on the temporary construction track, as shown in Fig. 12. To prevent the traveler, from tipping, it was chained down when setting the first slab. After this slab was placed, however, a plank was laid on top of it, and then a traveler was used spanning the entire trestle. With these travelers it was possible to set the floor slabs very carefully and accurately. Accuracy in setting was essential, as the bottom edges of the longitudinal joints had to be flush in order to grout these joints. Accuracy in placing the slabs was essential also, on account of the method of fastening used.

In casting the outside slabs for the floor a row of 1½-in. holes 6 in. deep was cored in the slabs. After the slabs had been set, rods 12 in. long were inserted in these



Gantry Traveler straddles Track and overhangs North Side. Floor Slabs are run underneath Traveler, picked up by two, five-ton Blocks, and moved over into Place; then lowered on Cap over Dowels cast in Concrete. When two North Slabs are set and grouted for some Distance, say 100 Bents, Track is then thrown over on Slabs. Temporary Caps and Stringers are taken ahead for further Use. The Forms for South Side Half Caps are then placed and Concreted in same Way as the North Side

FIG. 12. TRAVELER FOR SETTING FLOOR SLABS

holes and grouted in place. These projecting dowels hold the parapet in place on the floor. The parapet is of simple form, 15 in. in height with arch openings. Besides acting as a curb, it supports a galvanized-pipe railing, the top of which is 43 in. above the floor. The wearing surface of the roadway is a layer of asphalt

1½ in. thick. The roadway has a 2-in. crown at the center, this crown being formed by casting the trestle caps 2 in. higher at the center than at the sides.

The unit system of construction adopted in building the trestle not only produced a permanent structure built of uniformly high-quality material at a low cost, but enabled the work to be prosecuted very rapidly. The first concrete pile for the trestle was driven on Jan. 3, 1915, and the last concrete pile on Oct. 1. As may be gathered from the description, the different parts of the work were being carried forward at the same time the piles were being driven, so that the entire floor of the trestle with wheel guard in place was complete on Dec. 11, 1915; and on Dec. 22 the first automobile was driven across the bridge. There still remains to be constructed a bascule bridge of short span crossing a navigation channel at the east end of the trestle. A temporary roadway has been built around this, however, and the whole structure is expected to be open for traffic in February, 1916.

In carrying on its work of highway construction the California Highway Commission furnishes to contractors the crushed rock, sand and cement for concrete, and any steel used for reinforcing. A special freight rate of about one-half the regular rate is made by the railways of California for material for use on the state highways. This is one reason why the commission has adopted the policy of furnishing the materials to the contractors. In the Yolo bypass trestle the total amount of material is 21,692 tons of crushed stone, 12,553 tons of sand, 32,000 barrels of cement and 2,200 tons of reinforcing steel. The cost of these materials was in the neighborhood of $148,000. The payments to the contractor for the trestle, the Graff Construction Co., will aggregate about $246,000. The total cost of the trestle will be under $395,000. The total length of the trestle is 16,310 ft., or 3.09 mi. One-seventh of this distance is of wooden construction. The cost of this, however, is included in the contract price quoted, so that the total cost of the concrete trestle is in the neighborhood of $130,000 per mi. Austin B. Fletcher is the Chief Engineer of the California Highway Commission, and William S. Caruthers is division engineer of the division in which the Yolo bypass trestle is included.

Property Owners Asked To Slope Street-Railway Cut

Kansas City, Mo., has spent five years and about $400,000 digging a cut for a 60-ft. street carrying two tracks of the Metropolitan Street Ry. Co. The cut is 50 ft. deep, three city blocks in length, in rock and earth. The line was designed to be an outlet for traffic from the new Union Station to the south residence district. About four months ago, after the work had been completed, a large rock broke off and rolled down the steep slope, breaking a trolley pole at the bottom. Six weeks later another rock weighing several tons broke loose and struck the track with sufficient impact to bend the rails. The board of control of the railway thereupon refused to operate cars through the cut until the latter was made safe.

In excavating the cut the contractors used heavy charges in blasting, which shattered the rock badly. The sides were left almost vertical. The formation is made up of strata of limestone with intervening strata of shale and dirt. When exposed to the weather, the shale disintegrates so that the rock ledge above is subjected to cantilever stresses, causing it to fail. It is stated that

STRATIFIED ROCK IN CUT FOR STREET RAILWAY AND STREET IN KANSAS CITY

the sides of the cut should be graded to a slope of 1:1. The character of the rock is shown in the view.

The railway referred the matter to the city, under the jurisdiction of which the work was done. The city engineer, having no jurisdiction outside the slope lines, referred the matter to the legal department of the city and was advised that there was an ordinance on file which called upon the adjacent property owners to grade their property to such a slope as would make the street safe.

The park board in grading back for the station plaza will grade the street for about half its length on the east side of the cut. Only one property owner on the west side has announced his intention of grading it back. In the meantime the city has been unable to lay the asphalt pavement. Probably the matter will be held in abeyance until the park board has completed its grading, when some action may be taken to force the abutting property owners to observe the ordinance.

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High Sulphur Does Not Injure Openhearth Steel

By J. S. Unger*

SYNOPSIS—As a result of the unwillingness of the Society of Automobile Engineers to accept high-sulphur steel specifications, the Carnegie Steel Co. has carried on a long series of practical studies of the behavior of steels alike except for sulphur content. Some of the results were presented in a paper before the annual meeting of the society in New York, Jan. 6, 1916, and are reviewed here. Rivets, chains, tubes, channels, plates, sheets, rails, axles, drop forgings, etc., were made, and the higher-sulphur pieces were generally as good as those of lower content.

The manufacture of steel in quantities of several tons at one time began when the bessemer process was introduced about 50 years ago. Chemical analyses at that time were crude, or not made at all. Failures due to poor raw material or improper metallurgical treatment were common. Sulphur was largely blamed for such results, and a strong prejudice against it was established. Rarely has it been questioned, nor have many efforts been made to establish the truth, until at the present time few are ready to believe that sulphur up to a reasonable amount, say under 0.100% does not affect, or at the most only slightly influences, the working properties during manufacture or the quality of the finished steel.

The purpose of this investigation was to prepare steels of different degrees of hardness, each containing varying amounts of sulphur, then work these steels into finished products and examine them carefully during the manufacture and after completion for difference in quality.

Three heats of steel of 68 tons each were made. These were low-sulphur basic openhearth steels of soft, medium and moderately hard varieties of approximately 50,000, 70,000 and 90,000 lb. tensile strength, the carbon contents being 0.09, 0.32 and 0.51% respectively. No selection of stock or furnace was made, the furnaces being taken at random. The heats were cast into twenty-four 18x20-in. ingots, of 6,300 lb. each. Twelve ingots from each heat were used in the investigation, or a total of 100 tons. After a discard had been made to eliminate any highly segregated or streaked condition in the steel and the regular waste provided for, about 50 tons of steel was used in the tests carried out.

The sulphur content of the ingots was increased progressively by adding amounts of sulphur to different ingots from the same heat, raising the amounts in the higher-sulphur ingots of the series greatly beyond that ordinarily found in commercial steels. The sulphur additions were made in the pure powdered form to the ingots during pouring. The aim was to obtain steels that, excepting sulphur, would be alike in manufacture and composition, thus keeping out any variables and furnishing an opportunity to study the effect of sulphur alone.

The ingots were rolled into such sizes as would be needed to fabricate the different steels, either by hot or cold working, into such finished articles as they were best adapted to by composition. Sheets, wire products, rivets, chains, tubes, channels, plates, rails, axles and drop forgings were made. Owing to the great variety of materials made, it was not always possible to use steel of the exact composition ordinarily employed for a certain purpose, as the steel was sometimes a little harder or softer than required. This feature does not, however, influence the comparative results. The manganese of the three heats was 0.43, 0.62 and 0.67% respectively.

The ingots were heated to 1,250° C. and then rolled in the regular way, no attempt being made to give the higher sulphurs any preference. All ingots were rolled, except the two highest-sulphur ingots of the 0.09% carbon heat, containing 0.250 and 0.254% sulphur. These ingots cracked badly in rolling and were removed from the roll tables and scrapped. In rerolling from the blooms, billets or slabs into finished material, no trouble was experienced nor any difficulties met.

Table 1 shows the chemical composition of each heat and the sulphur content of each ingot.

TABLE 1. CHEMICAL ANALYSES AND PURPOSES OF HIGH-SULPHUR STEEL

Basic Openhearth Heat No. 81,160:
Chemical analysis—carbon, 0.09; manganese, 0.43; phosphorus, 0.012; sulphur, 0.031.
Sulphur content in ingots—0.030, 0.031, 0.050, 0.060, 0.090, 0.116, 0.140, 0.160, 0.180, 0.250, 0.254.
Purposes for which used—rivets, chains, sheets, wire, tubes and pipe.
Basic Openhearth Heat No. 71,163:
Chemical analysis—carbon, 0.32; manganese, 0.62; phosphorus, 0.014; sulphur, 0.032.
Sulphur content in ingots, 0.032, 0.068, 0.108, 0.146, 0.190, 0.230.
Purposes for which used—drop forgings, channels, plates and tubes.
Basic Openhearth Heat No. 76,185:
Chemical analysis—carbon, 0.51; manganese, 0.67; phosphorus, 0.015; sulphur, 0.025.
Sulphur content in ingots—0.025, 0.055, 0.095, 0.135, 0.167, 0.230.
Purposes for which used—axles, drop forgings, rails and wire rope.

*Manager, Central Research Bureau, Carnegie Steel Co., Duquesne, Penn.

Some 8-in. 11½-lb. channels were rolled, with sulphur running from 0.032 to 0.230%. No tearing or red shortness was noticeable on the thin flanges of the higher sulphurs.

The ability to weld the soft steel of 0.09% carbon was shown by ¾-in. hand- and machine-made chain. Three pieces of each sulphur content were made. The short pieces of three links each were tested to destruction (see Table 2). The greater average strength of the hand-made chain over the machine-made is not due to better workmanship, but to the fact that the lap in the hand-made chain is almost twice as long.

No trouble was experienced in either the hand- or machine-made chain until 0.110% sulphur was reached, 0.180% sulphur acting similarly. It was found that both could be welded perfectly at the regular temperature and did give good results, but that lowering the welding temperature about 100° C. prevented any cracking or crumbling of the steel in welding.

The evidence seems to show that good and bad welds are more a question of heating and workmanship than of either high or low sulphur, as either kind of weld is found in any of the chains tested.

TABLE 2. BREAKING LOAD OF ¾-IN. CHAIN*

Carbon Content, %	Sulphur Content, %	Breaking Load, Hand-Made Chain, Lb.	Breaking Load, Machine-Made Chain, Lb.
0.09	0.030	31,480	32,800
		39,630	33,300
0.09	0.060	40,710	35,630
		41,470	31,600
0.09	0.090	40,820	23,300
		30,940	24,000
0.09	0.140	40,710	26,450
		37,690	22,700
0.09	0.180	32,990	31,650
		40,390	31,200

* Rolled $\frac{1}{16}$ in. light in gage.

A number of rivets, ¾ in. in diameter by 2 in. long under the head, of the 0.09% carbon steel were made and subjected to the various hot and cold tests without any apparent differences. Ten bars, having two $\frac{13}{16}$-in holes drilled 2 in. from one end, were riveted together by machine at an estimated temperature of 1,200° C. These bars were then tested with the results shown in Table 3. Practically no difference was observed in the results.

A number of bars from both the 0.32% and the 0.51% carbon heats of various sulphur contents, 2x2 in. by 16 ft. long, were rolled and sent to two prominent automobile manufacturers with a request to drop forge them in accordance with their regular practice into such shapes as would indicate if any difficulties would be encountered in the heating or forging. The flash or excess metal forced out between the dies was not always sheared off, it being allowed to adhere to the forging to show any tearing at the thin outside edges. The appearance of the flash seems to furnish the strongest evidence of the ability of the high-sulphur steels to stand severe hot work.

TABLE 3. SHEARING STRENGTH OF RIVETED JOINTS

Carbon Content %	Sulphur Content %	Shearing Strength, in Lb.
0.09	0.030	48,900
0.09	0.060	48,300
0.09	0.090	48,800
0.09	0.140	46,700
0.09	0.180	47,400

When finished these forgings were cleaned by dilute acid or the sand blast and then carefully inspected by the manufacturers and the author to detect any surface or other defects, but no differences could be observed in the high- and low-sulphur steels of either carbon.

A number of No. 26 gage sheets were rolled, then galvanized and afterward made up into spouting. In seaming and beading the spouting, no cracks developed in any specimen, while the coating adhered as closely to one sheet as to another.

A number of milk-can bases were made of [illegible] carbon steel of different sulphur contents. These bases were intended for 5-gal. cans, were 11 in. in diameter and of No. 16 gage sheet. The work done was very severe, being a reverse draw with two operations in the press. No differences were noticed in stamping any of the specimens.

Tensile specimens were machined from the drop forgings of 0.32% carbon, after they had been subjected to the heat-treatment given in Table 4. Similar tests after

TABLE 4. TENSILE TESTS OF HEAT-TREATED KNUCKLES*

Carbon Content, %	Sulphur Content, %	Elastic Limit, Lb. Per Sq.In.	Tensile Strength, Lb. per Sq.In.	Elongation in 2 In., %	Reduction of Area, %
0.32	0.032	62,250	83,250	30.0	69.0
0.32	0.068	49,375	78,375	31.5	62.8
0.32	0.108	52,750	77,750	30.0	58.0
0.32	0.146	58,875	77,875	27.0	61.3
0.32	0.190	51,875	76,875	28.0	53.8
0.32	0.230	57,250	76,250	29.0	53.8

*Annealed at 900° C., reheated at 829° C., quenched in water and drawn at 538° C.

treatment were made from the 1¼-in. diameter rounds used in drop forging from the 0.32 and 0.51% carbon steels. The results obtained are given in Table 5.

Casehardening; Machining; Tensile Tests

Short pieces of ¾-in. rounds from the 0.09% carbon steel were packed in ordinary casehardening compound in the same container, then heated to 900° C. for 12 hr., afterward reheated to 860° C. and quenched in cold water.

TABLE 5. TENSILE TESTS OF HEAT-TREATED 1¼-IN. ROUNDS FORGED FROM 2x2-IN. BILLETS

Carbon Content, %	Sulphur Content, %	Elastic Limit Lb. per Sq.In.	Tensile Strength Lb. per Sq.In.	Elongation in 2 In., %	Reduction of Area, %
0.32*	0.032	48,650	80,250	30.5	70.1
0.32*	0.068	48,550	75,550	32.8	68.8
0.32*	0.108	46,400	75,800	30.2	68.7
0.32*	0.146	46,700	73,350	31.5	67.3
0.32*	0.190	45,450	71,550	33.2	66.3
0.32*	0.230	45,850	70,100	31.5	65.0
0.51†	0.025	70,400	111,900	20.3	56.8
0.51†	0.055	76,300	120,800	19.7	51.3
0.51†	0.095	73,950	119,400	19.5	51.5
0.51†	0.135	76,800	120,600	18.3	49.2
0.51†	0.167	73,200	111,750	17.5	45.4
0.51†	0.230	66,350	106,550	20.5	44.7

*Heated to 830° C., held for 20 min., quenched in water drawn at 600° C. for 30 min.

†Heated to 816° C., held for 20 min., quenched in water drawn at 565° C. for 30 min.

The surface of the bars was roughly polished and the scleroscope hardness determined at several points on the surface. The depth of case and hardness were the same for each bar, regardless of the sulphur content.

Where any machining was done on the finished material, or in preparing test specimens before and after treatment, no material differences were found. The only noticeable thing was that the higher-sulphur steels of any

TABLE 6. THREADING TESTS OF 1¼-IN. PIPE (0.09 CARBON STEEL)

Carbon Content, %	Sulphur Content, %	Cutting Force, in Lb.*
0.09	0.031	73.5
0.09	0.050	70.6
0.09	0.090	68.5
0.09	0.116	62.3
0.09	0.160	61.2

* A 22½-in. arm attached to the die ran to a dynamometer.

carbon gave a smoother machined surface than the lower-sulphur under the same condition of feed, speed or depth of cut. Table 6 shows the average force required while threading ten samples of each sulphur content.

Tensile tests of ¾-in. rounds of 0.09% carbon, of 8-in. channels of 0.32% carbon and of axles of 0.51%

carbon, all in an untreated condition, are shown in Table 7. The results on the soft steel are the same. In the medium steel there is a slight falling off in the physical properties when the sulphur exceeds 0.100%. The highest carbon, giving the results on specimens taken at the

TABLE 7. TENSILE TESTS OF HIGH SULPHUR STEELS

Carbon Content, %	Sulphur Content, %	Elastic Limit, Lb. per Sq.In.	Tensile Strength, Lb. per Sq.In.	Elongation in 8 In., %	Reduction of Area, %
		Untreated ¾-In. Diameter Rounds			
0.09	0.030	31,360	50,460	30.8	64.2
0.09	0.060	32,740	50,900	30.2	65.3
0.09	0.090	30,890	51,400	31.2	62.5
0.09	0.140	31,600	50,700	32.5	64.2
0.09	0.180	31,530	50,960	30.7	62.3
		Tensile Tests of 8-In. Channels			
0.32	0.032	45,300	71,580	25.5	54.8
0.32	0.068	45,000	70,060	26.2	54.8
0.32	0.108	47,110	70,670	24.2	52.9
0.32	0.146	46,210	70,060	26.2	50.9
0.32	0.190	48,930	70,060	24.2	48.4
0.32	0.230	47,250	67,920	24.5	47.9
		Tesile Tests of Untreated Axles*			
0.51	0.025	44,320	92,160	22.0	34.5
0.51	0.055	41,250	91,670	20.5	35.7
0.51	0.095	43,220	85,650	22.0	35.8
0.51	0.135	35,770	81,330	23.0	35.9
0.51	0.167	35,400	80,340	22.0	34.3
0.51	0.230	36,390	80,060	22.0	34.6

*Axles 4¼ in. in diameter at center. Journal 4¼ x 8 in.

edge, shows that as the sulphur rises there is a decrease in the ultimate strength but an increase in the toughness, as shown by the reduction of area. Specimens cut halfway to center of axles gave similar results.

The bending qualities of the 0.09% carbon steel is shown in the tests of rivets, the bending quality of the 0.32% carbon steel in the opening and closing tests of the 8-in. channels. Bending tests were not made on full-sized material made from the 0.51% carbon steel.

In addition to the tests mentioned above, deflection tests were made on the full-sized channels and drop tests

TABLE 8. DEFLECTION TESTS ON 8-IN. CHANNELS*

Carbon Content, %	Sulphur Content, %	Load to Deflection, Lb.	Permanent Deflection, In.
0.32	0.032	22,400	0.04
0.32	0.068	21,900	0.04
0.32	0.108	22,500	0.04
0.32	0.146	22,300	0.04
0.32	0.190	23,200	0.04
0.32	0.230	23,100	0.04

*Deflection tests made on full-sized 8-in. channels, 11.25 lb. per ft., 48 in. between centers. Load applied at center.

on the axles. The results of the deflection tests on the channels are shown in Table 8, and the results of the drop tests on axles in Table 9.

Summary of Results Secured

In practically every case finished articles in common everyday use were made. The work was carried out by the ordinary methods practiced, and in such sizes as are manufactured in the mills or shops. A great deal of work covering other lines of manufacture has been done, and additional work is either under way or in contemplation. The results presented speak for themselves and need very little comment. The author does not advocate paying no attention whatever to sulphur content of steel

TABLE 9. DROP TESTS OF 0.51-CARBON UNTREATED AXLES*

Sulphur Content, %	Number Blows to Break Axle	Deflection in In. After Each Blow Axles Turned Over After Every Second Blow: First Blow	Second Blow	Third Blow	Fourth Blow	Fifth Blow	Sixth Blow	Seventh Blow
0.025	33	4½	5½	3½	5½	3½	5½	3
0.055	29	4½	5½	3½	5½	3½	5½	3½
0.095	30	4½	5½	3½	5½	3½	5½	3½
0.135	30	4½	6	3½	6	3½	5½	3½
0.167	21	4½	5½	3½	5½	3½	5½	3½
0.230	14	4½	5½	4	5½	4	5½	5½

* Axles rough turned. Size 4¼ in. in diameter at center. Journal, 4¼x8 in. Weight of tup, 2,200 lb. Height of drop, 16 ft.

but believes firmly that a steel containing less than 0.100% is not necessarily bad, and that it will show little, if any, difference in quality when compared with the same steel of much lower sulphur, other conditions being the same.

Track-Scale Specification

The United States Bureau of Standards has just issued in preliminary draft a specification for railroad track-scales, thus taking the first big step toward regulating conditions in a field concerning which there has been much confusion and for some years past acrimonious discussion.

The specification defines the capacity of the scale as the weight of the heaviest car the scale will weigh, provided that it will support a train of such cars passing over the live rail without stresses in excess of those specified being developed in the members of the scale.

The stresses for all working parts of the scale are given in the accompanying table; no separate allowance for impact is necessary.

Nature of Stress	Cast Iron	Cast Steel	Wrought Iron	Structural Steel	High-Carbon Steel for Knife-Edges and Bearings
Tension	1,500	8,000	8,000	16,000	30,000
Compression	8,000	16,000	8,000	16,000	30,000
Transverse bending:					
Tension	2,000	8,000	8,000	16,000	30,000
Compression	8,000	16,000	8,000	16,000	30,000
Shear	2,500	6,000	....	7,000	....
Torsion	2,500	6,000	....	7,000	....

Stress per lineal inch of knife-edges, 4,000 lb. Compressive strength of concrete, 400 lb. per sq.in.

A representative car for calculations is one having 5½-ft. trucks with centers 22 ft. apart and centers of adjacent end trucks of coupled cars 12 ft. apart. Concerning other points the following items may be noted: The scale bridge should be of the articulated-girder type having "either separate girders that are properly joined at the supports or continuous girders with flexible sections at each support." Knife-edges should be used and not point or button bearings. They should be firmly fastened to the levers and so mounted that uniform contact and pressure will occur between the knife-edges and the bearings, the latter condition requiring reinforcement against transverse bending. The distance between fulcrum and load knife-edges in the main levers should not be less than 10 in. Nose irons and levers should make contact by machined surfaces. Adjustment of the nose irons should be of such type that the knife-edges will remain parallel to their original position. The adjustment is best made by a bronze machine screw, with number of threads per inch stamped on the head of the screw, and clamp screws provided to hold the nose iron in position. The normal position of the nose iron should be marked by match marks on the nose iron and the lever. The poise on the beams should have a horizontal line of motion when the beam is in midposition. The play of the beam in the trig loop should be 2% of the distance from the fulcrum knife-edge to the loop. The sensibility reciprocal, or the weight required on the platform to turn the beam from the horizontal to the top of the loop, should never be greater than 100 lb., and for a new scale should not be greater than 50 lb. The main beam should be notched at every 1,000 lb., and its graduation should represent not more than 6,000 lb. per in. Graduations of the fractional beam should not represent more than 200 lb. per in. and the graduation interval should be not less than one-half the sensibility reciprocal, or generally 50 lb., except for recording beams. The indicator of the fractional poise must be symmetrical with respect to the graduation. There should be no tare beam.

Draining the Roseau River Swamp in Minnesota

By George H. Herrold*

SYNOPSIS—The river had a winding course with very little fall through swamp lands, beyond which it had a steeper grade. Improving the channel and equalizing the grade give good drainage. The work is in a district difficult of access.

Drainage work now under way in Roseau County, Minnesota, provides for widening, straightening and deepening the Roseau River from Lake Roseau to the Canadian boundary (36 mi.) and for the immediate construction of lateral canals and ditches to reclaim 50,000 acres of swamp land owned by the state and 40,000 acres privately owned. This project is financed by the state and is under the jurisdiction of the State Drainage Commission.

The river flows almost directly north as far as the lake, which is a depression, or suck-hole, in the glacial drift, about 4 mi. south of the boundary. From this lake the water overflows and forms an impassable marsh covering over 300 sq.mi. The drainage area is 980 sq.mi. above the lake and 1,350 sq.mi. at the Canadian boundary.

West of the lake the river channel was almost undefined for 25 mi., its flow of 0.3 ft. per mi. not giving sufficient velocity to erode a channel. After passing the edge of the great moraine, it flows down the north slope between defined banks with a fall of 1½ ft. per mi. for 12 mi. to the boundary. Crossing at Caribou City, it continues to the Red River at Dominion City, Manitoba. The river channel and the auxiliary drainage works are shown in Fig. 1.

Development of some of the higher lands demonstrated the fertility of the soil. The state became interested through its holdings and investigated the possibilities of drainage. The examination resulted in dredging a small channel for the river from Roseau Lake west across the swamp to the steeper reach of the river (Fig. 4) and also in building laterals to drain land lying to the south.

The river channel was kept open by redredging for several years with little result, but the slight lowering of the water level made possible more careful exploration and survey. It was shown that the swamp lands were slightly lower than the dredged channel, that the fall in 24 mi. was only 0.3 ft. per mi., and that the 18-ft. fall of the river in the last 12 mi. within the United States must be distributed over the 24 mi. lying east to Roseau Lake. It was shown also that the entire country is underlain with hardpan of unknown thickness.

In 1913 the legislature appropriated $80,000 to improve the river and to provide an outlet for the drainage system. Surveys and estimates showed that this amount was sufficient to make a channel for 17 mi. east from the Canadian boundary. The estimate was based on a channel with a 60-ft. concave bottom and a grade line that would increase the fall through the marsh from 0.3 to 0.7 ft. per mi. This effect was accomplished by lowering the rived bed through the hardpan stratum underlying it in the west edge of the marsh. Cutoffs across long winding loops reduce the distance to a minimum and utilize the available fall to the best advantage.

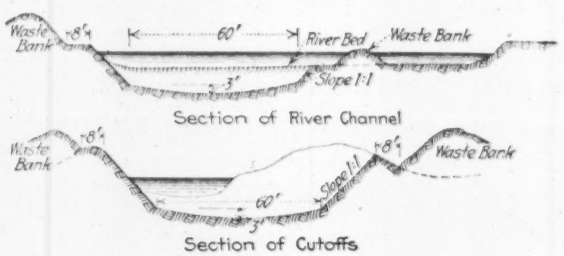

FIG. 2. CROSS-SECTION OF DREDGED CHANNELS

The distribution of cost is as follows: 450,154 cu.yd. of earth excavation at 10c., $45,105; 84,038 cu.yd. of hardpan at 25c., $21,010; two timber bridges, $3,000; moving one bridge, $500; removing sand bars, $700; right-of-way, damages due to cutoffs, etc., $2,500; surveys and supervision, $7,185; total, $80,000.

Dredging the River Channel

A contract was let to the Central Dredging Co., of Cleveland, Ohio, on a yardage basis. Work was started in August, 1914, and the 17-mi. channel is nearly completed. An additional appropriation of $55,000 has been made to complete the work to Roseau Lake, and the company will continue this in 1916. The plans for the second contract provide for diverting the river, before it enters the lake, by means of a 50-ft. channel gradually

*City Engineer's office, St. Paul, Minn.

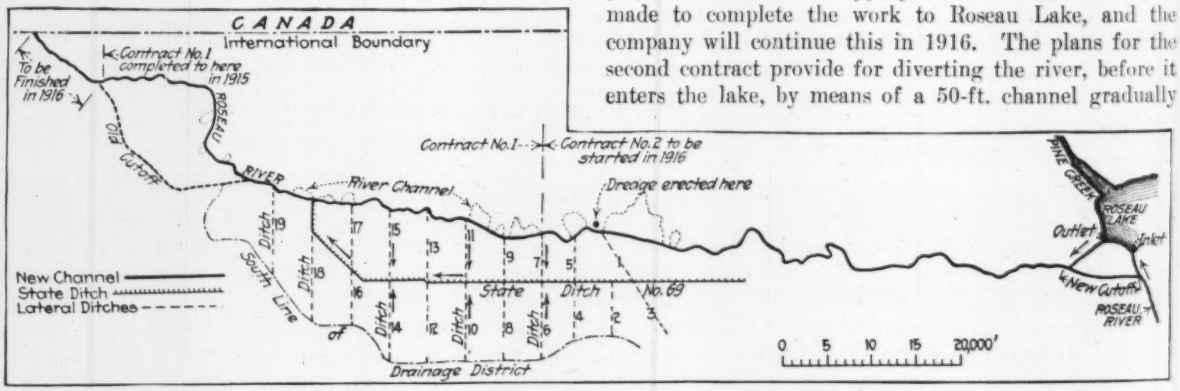

FIG. 1. THE ROSEAU RIVER DRAINAGE SYSTEM IN MINNESOTA

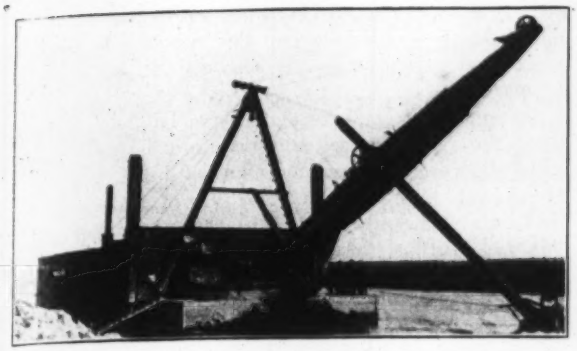

FIG. 3. DITCHING DREDGE ON THE ROSEAU RIVER CHANNEL IN MINNESOTA

widening to 60 ft. at the beginning of the first contract (Fig. 1).

Fig. 2 shows cross-sections of the main river channel and the cutoffs. The right-of-way for the former extends 33 ft. from the edge of each bank; on the cutoffs it is 200 ft. wide. Contracts were let also for state ditches Nos. 69 and 72, with laterals on all section lines. Ditch No. 72 is outside the southern limits of the district. The lateral ditches are 3 ft. deep at the summit and have a fall of 1 ft. per mi.

The river work was done with a Fairbanks dredge, shown in Fig. 3. This machine has a hull 40x90 ft., with vertical anchor spuds. It has a 72-ft. boom and a 2-yd. dipper of manganese steel fitted with teeth for the hardpan excavation. The maximum monthly yardage was 80,000 cu.yd.

With the great distance from railways and the lack of wagon roads it is difficult to obtain coal and camp supplies. The general method is to haul the coal over the ice during the winter and distribute it as nearly as possible where it will be wanted the coming season, but much coal distributed in this way was never found after the spring thaw. The mosquitoes constitute a plague during the working season.

At Roseau, Minn., a number of flat-bottom scows of 18-in. draft were built, and on these the dredging machinery, material and equipment were towed by a stern-wheel gasoline launch. The 72-ft. boom had a maximum depth of 7 ft. It was loaded on two scows, and the bridges along the route had to be cut, as they were too low for this clearance. Coal was taken in the same manner for the beginning of operations in 1914. The dredging outfit was unloaded at a loop in the river, as shown in Fig. 1; after being assembled, it cut its way through to the beginning of the contract. In the spring of 1915 the base for supplies was Ross, Minn. Later it was changed to Colienta, Manitoba, supplies being shipped in bond to this point and then hauled to the river by teams.

Good Results of Land Drainage

The results are far exceeding expectations. Already gas tractors hauling gang plows have been breaking up large tracts of land which a few years ago could not be crossed with a team and were dangerous to cross on foot. The cost to the state of draining its land is estimated at less than $3 per acre, and this land will sell for from $10 to $20 per acre. Lands privately owned which are benefited by this project are assessed their pro rata cost per acre benefited.

The adequacy of this improvement, from an engineering standpoint, is a question of considerable interest. The maximum flow is estimated at 1,200 sec.-ft., or 0.9 sec.-ft. per sq.mi. of drainage area, which is equivalent to 12 in. of rainfall. The average rainfall is 20 in., with a range of 16 to 32 in. The mean temperature is 35° F. The carrying capacity of the new river channel, using the cross-section shown and 8-ft. depth of water, is 1,046 sec.-ft., or less than the flood flow under conditions prior to the making of the improvement.

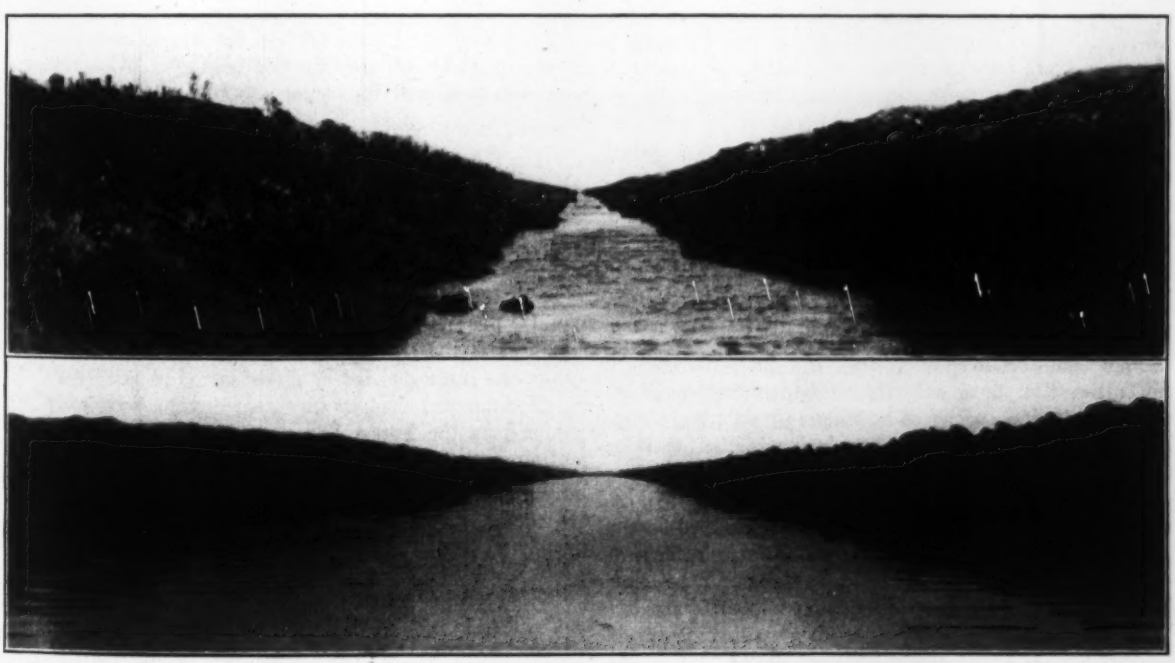

FIG. 4. THE ROSEAU RIVER CHANNEL ACROSS THE SWAMP LANDS OF MINNESOTA
Above is the first dredged channel. Below is the channel as now improved